Biology - 9700

■ 38 Questions

Topics Covered :

✓ 6.1 - Structure of nucleic acids and replication of DNA
✓ 1.2 - Cells as the basic units of living organisms
✓ 6.2 - Protein synthesis
✓ 3.2 - Factors that affect enzyme action
✓ 1.1 - The microscope in cell studies
✓ 11.1 - The immune system
✓ 11.2 - Antibodies and vaccination
✓ 5.2 - Chromosome behaviour in mitosis
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Question No 1 - (9700_m25_22_5)

Subsection Topics: (a) : 6.1 - Structure of nucleic acids and replication of DNA, 1.2 - Cells as the basic units of living organisms | (b) : 6.2 - Protein synthesis | (c) : 3.2 - Factors that affect enzyme action

(a) Eukaryotic cells and prokaryotic cells contain DNA.

Complete the passage about DNA in eukaryotic cells and prokaryotic cells, using the most appropriate terms.

In eukaryotic cells, the DNA is located mainly in the chromosomes of the nucleus. Chromosomal DNA is associated with proteins called ..... . Two other eukaryotic cell structures that contain DNA are mitochondria and ..... .

In prokaryotic cells, for example ....., the DNA is found in the ..... and is usually circular.

[4]

(b) Fig. 5.1 shows transcription of the first six nucleotides of a gene by the enzyme RNA polymerase. The bases of the first six nucleotides on DNA strand **X** are shown, but the bases on the template DNA strand are **not** shown.

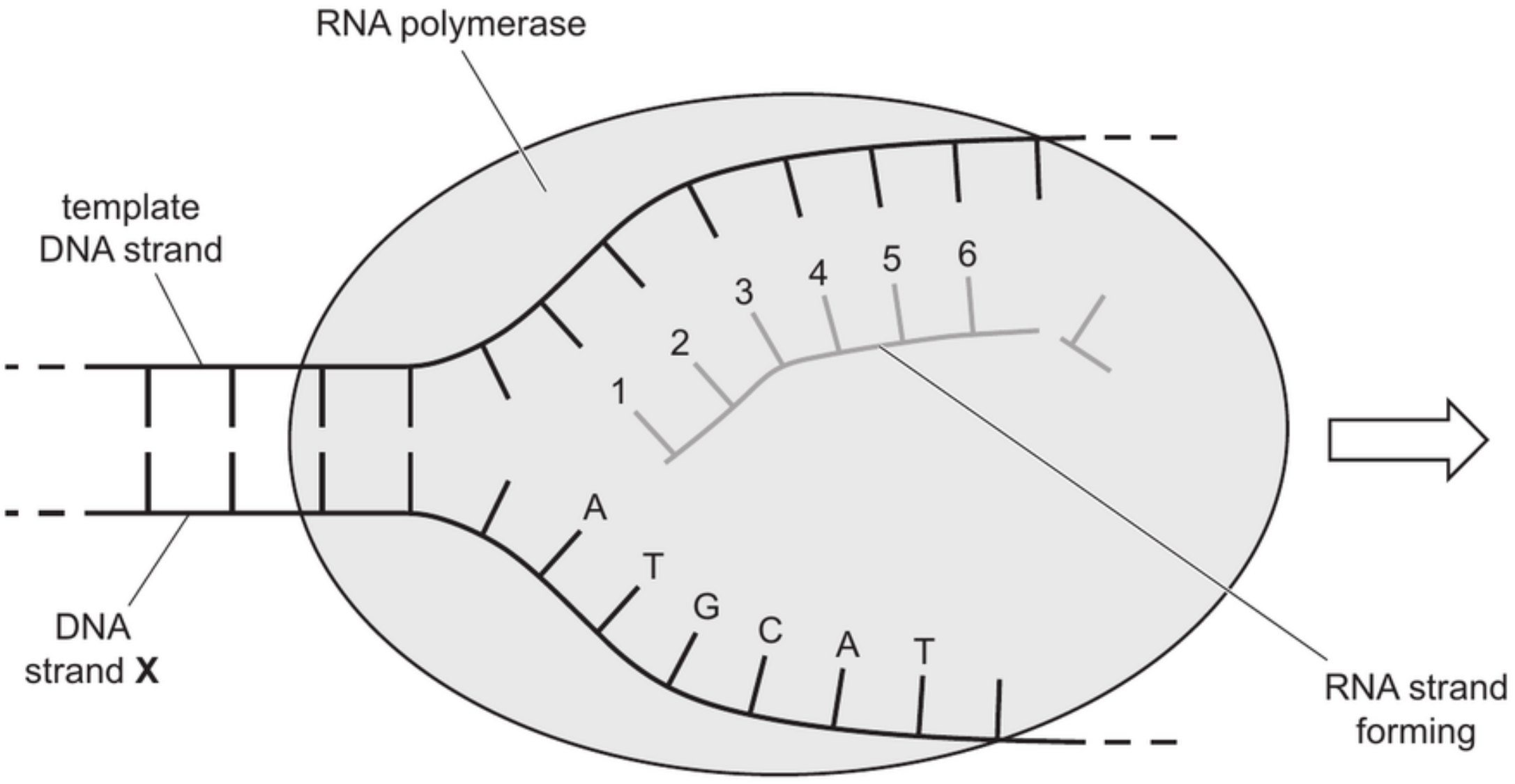

Fig. 5.1

(i) State the term used to describe the non-template DNA strand labelled **X** in Fig. 5.1.

..... [1]

(ii) Name the RNA strand formed during transcription of a eukaryotic gene.

..... [1]

(iii) Complete Table 5.1 to show the letters of the six bases indicated on Fig. 5.1 by the

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numbers 1 to 6.

Table 5.1

1	2	3	4	5	6

[1]

(c) RNA polymerase is composed of several polypeptides that move together and change shape as the enzyme performs its functions.

The death cap mushroom, *Amanita phalloides*, produces a toxin called alpha-amanitin, which binds to RNA polymerase at a site other than the active site. Alpha-amanitin reduces the activity of RNA polymerase.

Use the information provided to suggest how alpha-amanitin reduces the activity of RNA polymerase.

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[Total: 10]

Question No 2 - (9700_m24_22_6)

Subsection Topics: (a) : 1.1 - The microscope in cell studies | (b) : 11.1 - The immune system | (c) : 6.2 - Protein synthesis, 11.1 - The immune system | (d) : 11.2 - Antibodies and vaccination

Fig. 6.1 is a simplified diagram representing a section through the human immunodeficiency virus (HIV) particle that causes HIV/AIDS. The diagram shows the virus particle about to attach to the cell surface membrane of a T-helper cell at a receptor protein called CD4. A second protein (coreceptor) called CCR5 is also necessary for the virus particle to enter and then infect the T-helper cell.

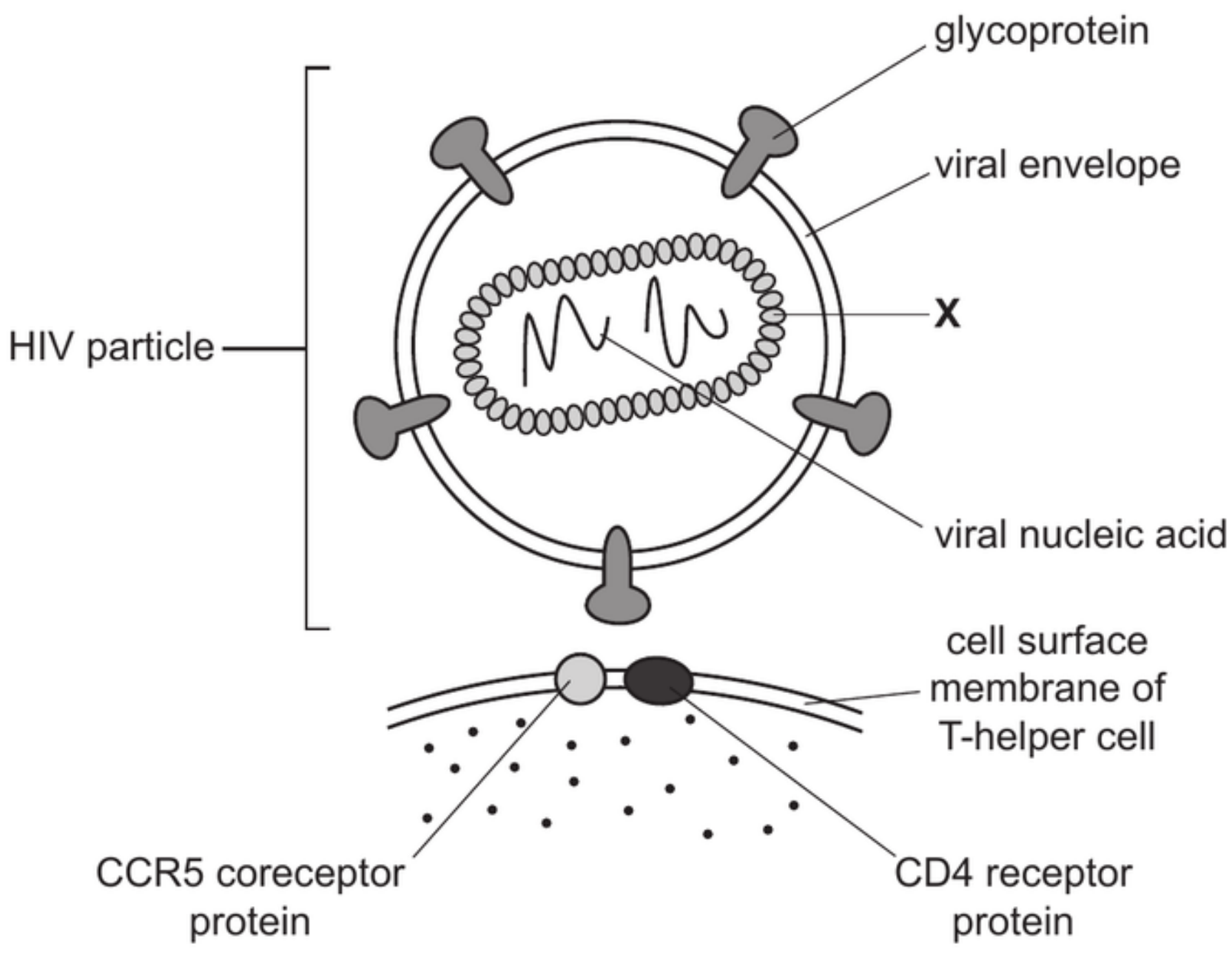

Fig. 6.1

(a) Identify structure **X** in Fig. 6.1.

..... [1]

(b) Explain how the ability of the immune system to resist the damaging effects of a pathogen is affected by destruction of T-helper cells.

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(c) Studies have shown that some individuals did **not** become infected with HIV even though

(c) Studies have shown that some individuals did **not** become infected with HIV even though they were repeatedly exposed to the virus. Later discoveries indicated that these individuals had a mutation in the gene for the CCR5 coreceptor protein.

Suggest how mutation of the gene for the CCR5 coreceptor protein provided protection against HIV infection.

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..... [1]

(d) The use of monoclonal antibodies against the CCR5 coreceptor protein (anti-CCR5) has been shown to be effective in the treatment of HIV infection.

Outline how anti-CCR5 monoclonal antibodies can be synthesised in the laboratory using the hybridoma method.

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..... [3]

[Total: 8]

Question No 3 - (9700_m24_22_4)

Subsection Topics: (a) : 6.1 - Structure of nucleic acids and replication of DNA, 6.2 - Protein synthesis | (b) : 5.2 - Chromosome behaviour in mitosis | (c) : 2.2 - Carbohydrates and lipids | (d) : 2.2 - Carbohydrates and lipids

(a) Table 4.1 shows a sequence of 12 nucleotides in the template strand of a short length of a DNA molecule, the corresponding primary transcript and the four amino acids coded for by the sequence. The table is incomplete.

(i) Complete Table 4.1 to show the sequence of nucleotides in the primary transcript that would result from transcription of this short length of DNA.

Table 4.1

position of nucleotide	1	2	3	4	5	6	7	8	9	10	11	12
DNA template strand	C	A	C	T	A	C	T	C	C	A	A	C
primary transcript												
amino acid	aa1			aa2			aa3			aa4		

[1]

(ii) Table 4.2 shows all the possible template strand DNA triplets that code for the amino acids labelled aa1, aa2, aa3 and aa4 in Table 4.1.

Table 4.2

amino acid	DNA triplets
val	CAA, CAG, CAT, CAC
arg	GCA, GCG, GCT, GCC, TCT, TCC
met	TAC
leu	AAT, AAC, GAA, GAG, GAT, GAC

Complete Table 4.3 to identify the four amino acids labelled aa1, aa2, aa3 and aa4 in Table 4.1.

Table 4.3

	aa1	aa2	aa3	aa4
amino acid				

[1]

(iii) One type of gene mutation is caused by the substitution of a DNA nucleotide.

Using the information in Table 4.2, state **and** explain the effect on the final protein structure of a substitution of the nucleotide at position 3 in Table 4.1.

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..... [2]

(iv) A second type of gene mutation is caused by the deletion of a DNA nucleotide.

Using the information in Table 4.2, state **and** explain the effect on the final protein structure of a deletion of the nucleotide at position 3 in Table 4.1.

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(b) Replication of nuclear DNA occurs just once in every mitotic cell cycle. Six named events associated with the mitotic cell cycle are listed. The events are **not** listed in any particular order.

Draw a circle around each event where replication of nuclear DNA occurs.

cytokinesis

interphase S phase

G_2 phase G_1 phase

mitosis

[1]

(c) Outline how DNA is replicated inside the nucleus.

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Question No 4 - (9700_s24_21_3)

Subsection Topics: (a) : 6.1 - Structure of nucleic acids and replication of DNA | (b) : 6.1 - Structure of nucleic acids and replication of DNA, 3.2 - Factors that affect enzyme action | (c) : 10.1 - Infectious diseases

(a) A class of students was studying the features of some human pathogens. One of the students constructed a flow chart to identify four different human pathogens. The student used information about the structure and mode of transmission of each of these pathogens.

Fig. 3.1 shows the partially completed flow chart.

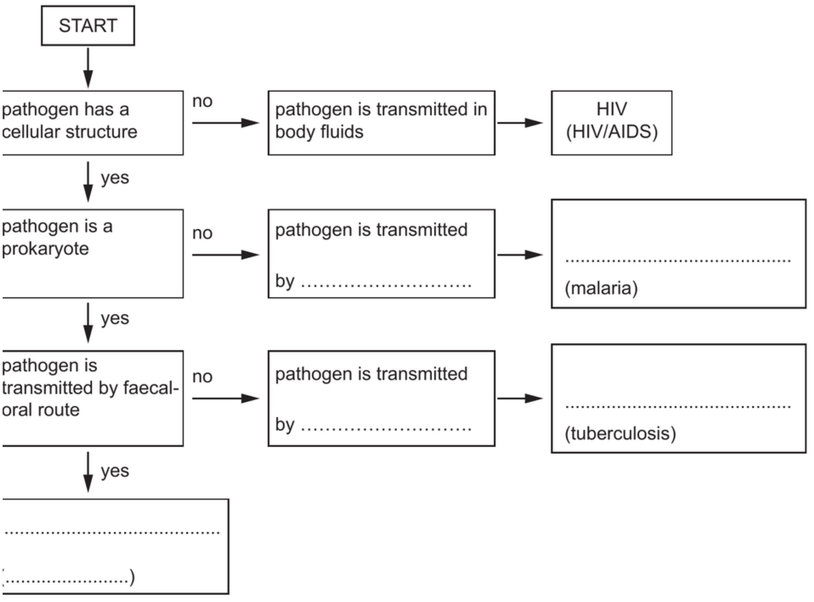

Fig. 3.1

Complete the flow chart in Fig. 3.1 by identifying:

- the modes of transmission
- the scientific names of the pathogens
- the name of one of the diseases.

[5]

(b) HIV has a nucleic acid core of RNA. The virus also contains the enzyme reverse transcriptase.

After HIV enters T-lymphocytes, reverse transcriptase catalyses the formation of DNA using activated DNA nucleotides with the viral RNA as a template.

Some drugs, such as tenofovir, have been developed to inhibit the action of reverse transcriptase.

The structure of tenofovir is similar to the structure of deoxyribose adenosine monophosphate, as shown in Fig. 3.2.

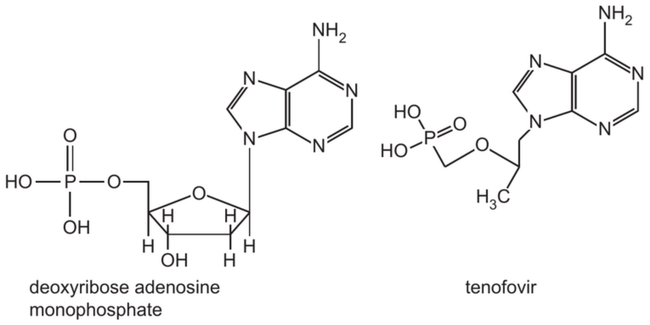

Fig. 3.2

After tenofovir is absorbed into cells it is phosphorylated twice and can be used by reverse transcriptase in the synthesis of DNA.

When a tenofovir molecule is added to the DNA strand being synthesised, the process stops.

Suggest the mechanism of action of tenofovir to prevent the synthesis of DNA by reverse transcriptase. Use the information in Fig. 3.2 in your answer.

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…… [2]

(c) Pre-exposure prophylaxis (PrEP) is the use of therapeutic drugs to prevent the replication of HIV in the body following infection. The drugs are taken by people who are at risk of becoming infected. Tenofovir is one of these therapeutic drugs.

In 2016, the United Nations (UN) set a global target of 3 million PrEP users by 2020.

Table 3.1 shows the number of people across the world who received a therapeutic drug for PrEP in each of the years between 2012 and 2019.

Table 3.1

year	number of people who received PrEP
2012	10 000
2013	15 000
2014	27 500
2015	57 500
2016	95 000
2017	145 000
2018	340 000
2019	605 000

(i) Calculate the percentage of people who received PrEP in 2019 as a percentage of the target set by the UN in 2016.

Give your answer to the nearest whole number.

..... % [1]

(ii) PrEP does not prevent transmission of HIV.

State **and** explain how health authorities can reduce the transmission of HIV.

In the mesophyll tissue of leaves, products of photosynthesis can be used to synthesise organic compounds, such as the polysaccharide cellulose and some amino acids.

A source of nitrogen for amino acid synthesis can be provided by nitrate ions that have been taken up in the roots and transported to the leaves.

(a) Describe the structure of a cellulose molecule.

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..... [3]

(b) Studies of nitrate uptake and nitrate metabolism help to provide information to scientists who are investigating ways to increase the yield of crop plants.

The first step of nitrate metabolism in leaf cells is the reduction of nitrate to nitrite, catalysed by the enzyme nitrate reductase. The activity of the enzyme can be studied by detecting the presence of nitrite formed.

(i) Researchers have found that adding nitrate to leaf tissue results in an increase in messenger RNA (mRNA) molecules of the gene *NR*, which codes for nitrate reductase.

State **one** benefit to leaf cells of an increase in mRNA molecules of gene *NR* after the addition of nitrate.

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..... [1]

(ii) One method used to detect the presence of nitrite formed from the reduction of nitrate in leaf tissue involves:

- using an inhibitor to prevent nitrite from taking part in further reactions in the leaf tissue
- immersing the leaf tissue in a solution containing a colourless test reagent.

The nitrite from the leaf tissue enters the surrounding solution, changing the colour of the solution to magenta (red-purple).

Suggest why using a colorimeter can improve this method to detect the presence of nitrite.

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..... [2]

(c) In the leaf, transport of amino acids from mesophyll cells to companion cells involves using a number of different membrane transport proteins called amino acid transporters.

There is evidence that amino acids can move from the apoplast into the cytoplasm of a companion cell using the same transport mechanism that is used for sucrose transport.

(i) Outline **and** explain the sequence of events that occurs, which allows amino acids to be transported from the apoplast into the cytoplasm of a companion cell.

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(ii) Suggest why amino acid transporters are **not** needed to move amino acids from the companion cell into a phloem sieve tube element.

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..... [1]

To investigate nitrate uptake, roots can be cut and removed (excised) and placed in a buffered solution containing nitrate ions. The root tissue can be analysed to determine the quantity of nitrate taken up over a set time period.

(d) Excised roots of the crop plant maize, *Zea mays*, were placed in three different concentrations of nitrate solution: 0.2 mmol dm^{-3}, 1.0 mmol dm^{-3} and 5.0 mmol dm^{-3}.

The solutions were maintained at 30 °C and were aerated to provide a continuous supply of oxygen to the root tissue.

Nitrate (NO_3^-) uptake by the root tissue was determined each hour for five hours.

The results are shown in Fig. 4.1.

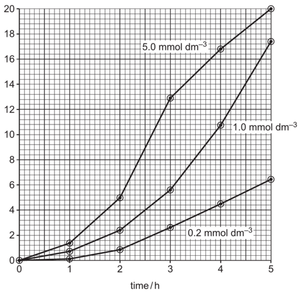

Fig. 4.1

Fig. 4.1 shows that the rate of nitrate uptake is very low initially and then increases for all three concentrations of nitrate solution tested.

Describe the **differences** in the **rates** of nitrate uptake for 5.0 mmol dm^{-3} nitrate solution compared with 0.2 mmol dm^{-3} nitrate solution, between 2h and 5h

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(e) The nitrate uptake of excised maize roots was investigated under different conditions.

Table 4.1 shows details and results for a control experiment and four modified experiments, **1**, **2**, **3** and **4**. The same concentration of nitrate solution was used throughout for all the experiments. All the results were taken after a set time period.

Table 4.1

experiment	temperature / °C	aeration	additional substances present in nitrate solution	nitrate uptake / μmol g^{-1} (fresh mass)
1	30	no	nitrogen gas bubbled through instead of oxygen	0.4
2	3	yes	none	0.6
3	30	yes	protein synthesis inhibitor	1.4
4	30	yes	antibacterial compound	10.0
control	30	yes	none	10.9

The results for experiments **1**, **2**, **3** and **4** in Table 4.1 can be compared to the results for the control experiment.

Discuss how comparing each of the results with the control provides information about:

- how nitrate ions are taken up by the root cells
- the factors affecting the uptake of nitrate ions.

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[Total: 17]

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Question No 6 - (9700_s24_22_1)

Subsection Topics: (a) : 9.1 - The gas exchange system | (b) : 1.1 - The microscope in cell studies | (c) : 8.1 - The circulatory system | (d) : 6.1 - Structure of nucleic acids and replication of DNA, 2.3 - Proteins, 6.2 - Protein synthesis

Smooth muscle is a tissue composed of smooth muscle cells. The cells contain cytoplasm packed with proteins that are involved in contraction and relaxation.

(a) Smooth muscle is present in the airways of the gas exchange system.

Explain how smooth muscle cells in the walls of the **bronchioles** contribute to the function of these airways.

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(b) When viewed in longitudinal section (LS), smooth muscle cells are elongated and taper at both ends. This is known as a fusiform shape. Each cell has a central nucleus, which also appears elongated.

Fig. 1.1 is a diagram of a smooth muscle cell to show the fusiform shape.

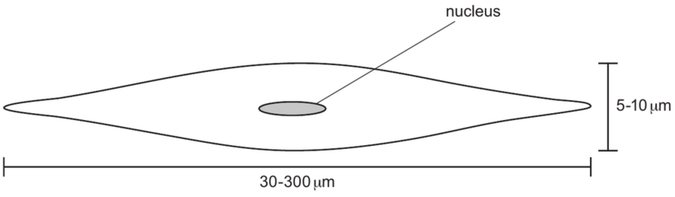

Fig. 1.1

A student used a microscope fitted with a calibrated eyepiece graticule to estimate that the length of one smooth muscle cell was 250 micrometres (μm).

(i) Name the type of microscope slide that the student used to calibrate the eyepiece graticule.

..... [1]

(ii) The smallest object the student can see without the use of a microscope is 0.2 mm in length.

Explain whether the student would be able to see a cell of length 250 μm without the use of a microscope.

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..... [1]

(c) Fig. 1.2 is a photomicrograph of smooth muscle tissue in the wall of the intestines. A capillary is visible in addition to smooth muscle cells.

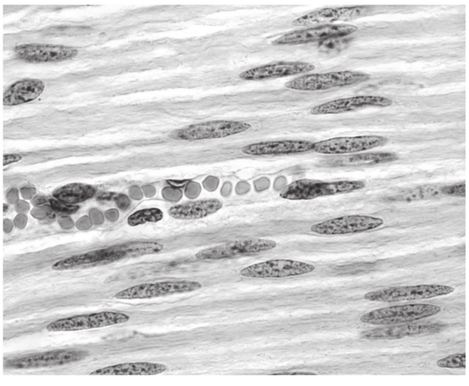

Fig. 1.2

(i) Outline the features that help to identify the blood vessel in Fig. 1.2 as a capillary.

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(ii) Explain how the structure of a capillary is related to its function in smooth muscle.

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(d) Caldesmon is a large protein with a number of binding sites to attach to other proteins.

Caldesmon exists in two different forms, H-caldesmon and L-caldesmon.

H-caldesmon helps to regulate contraction and relaxation in smooth muscle cells.

L-caldesmon is found in some non-muscle cells, where it also acts as a regulatory protein.

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- Caldesmon is coded for by a gene known as *CALD1*.
- *CALD1* has 17 exons.
- The primary structure of H-caldesmon has a repeating sequence in the middle of the amino acid chain that is **not** present in L-caldesmon.

(i) Researchers have discovered that a gene mutation is **not** the cause of the two different forms of caldesmon.

Explain what is meant by a gene mutation.

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..... [2]

(ii) Researchers now know that the two different forms of caldesmon are the result of events occurring **directly after** transcription of DNA. Changes occur to the primary transcript that is formed by DNA transcription.

Suggest how the smooth muscle cells and non-muscle cells can produce different forms of caldesmon from the same primary transcript.

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(iii) Suggest how the two different forms of caldesmon can still have similar functions, even though they have a different primary structure.

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Question No 7 - (9700_s24_23_6)

Subsection Topics: (a) : 6.2 - Protein synthesis | (b) : 6.1 - Structure of nucleic acids and replication of DNA

DNA and RNA are polynucleotides.

(a) Describe **three** ways in which the structure of messenger RNA (mRNA) differs from the structure of DNA.

In each of your answers, include information about the structure of mRNA **and** the structure of DNA.

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[3]

(b) Scientists have synthesised four synthetic bases, Z, P, S and B. The base pairings of the synthetic bases are shown in Fig. 6.1.

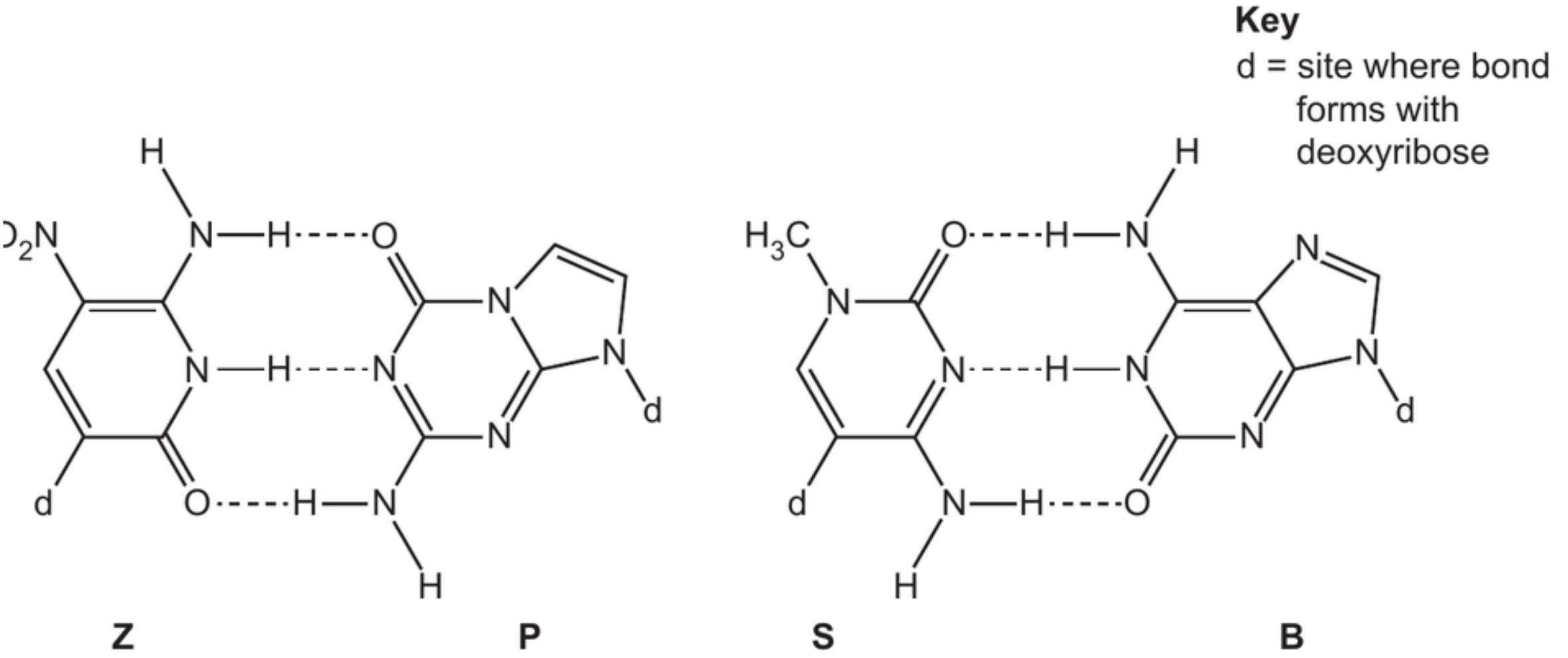

Fig. 6.1

(i) State the letters that represent the two purine synthetic bases in Fig. 6.1.

..... [1]

(ii) State **and** explain which DNA base pair is most similar to the synthetic base pairs in Fig. 6.1.

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[Total: 6]

Question No 8 - (9700_w24_21_4)

Subsection Topics: (b) : 7.1 - Structure of transport tissues, 7.2 - Transport mechanisms | (c) : 6.1 - Structure of nucleic acids and replication of DNA | (a) : 2.2 - Carbohydrates and lipids

(a) Fig. 4.1 shows the structure of sucrose, a disaccharide produced by plant cells.

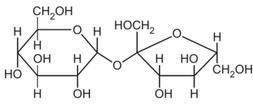


Fig. 4.1

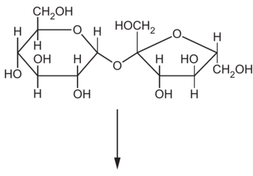
(i) Name the covalent bond that joins the two monomers in sucrose.

..... [1]

(ii) Sucrose is hydrolysed by the enzyme sucrase in the human digestive system.

The products of this hydrolysis reaction are the monosaccharides α-glucose and fructose.

Complete the diagram to show the hydrolysis of sucrose to form α-glucose and fructose.



[3]

(b) Plants transport sucrose from a source to a sink.

Fig. 4.2 is a scanning electron micrograph (SEM) of a transverse section through a plant tissue used to transport sucrose.

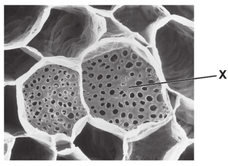


Fig. 4.2

(i) Name the structure labelled **X** in Fig. 4.2.

..... [1]

(ii) A scientist carried out an experiment to study carbohydrate transport in the stem of a woody plant.

Fig. 4.3 shows a plan diagram of a transverse section of the stem studied by the scientist. The position of the xylem tissue in the stem is shown.

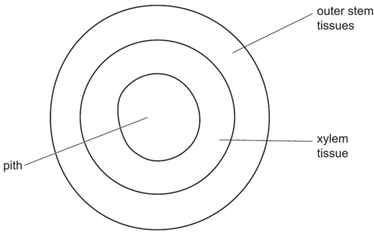


Fig. 4.3

The scientist carried out a set of experiments using plants of the same species.

In each experiment, a ring of tissue was removed from the outer stem of the plant, but the xylem tissue was left intact. This is shown in Fig. 4.4.

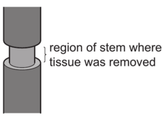


Fig. 4.4

The mass of carbohydrate transported to the lower part of the stem in 24 hours was recorded.

In each experiment a different percentage of the outer stem tissue was removed.

All other variables remained constant.

Table 4.1 shows the results of this investigation.

Table 4.1

percentage of outer stem tissue removed	mass of carbohydrate transported to lower part of the stem in 24 hours /mg
13	774
67	597
90	425
100	0

Explain the results shown in Table 4.1.

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(c) Sucrose is a sweet-tasting sugar found in many foods.

Some people become ill when they have sucrose in their diet. These people have a gene mutation in the gene coding for sucrase and cannot hydrolyse sucrose in the digestive system.

Scientists studying the DNA of people with this condition identified a deletion mutation in the gene coding for sucrase.

Suggest **and** explain why a person with this deletion mutation cannot digest sucrose.

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[Total: 13]

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Question No 9 - (9700_w24_22_3)

Subsection Topics: (a) : 6.1 - Structure of nucleic acids and replication of DNA | (b) : 6.1 - Structure of nucleic acids and replication of DNA

During transcription, base pairing occurs between nucleotides.

Fig. 3.1 is a diagram to show complementary base pairing between a DNA nucleotide and an RNA nucleotide.

Only the base pair is shown in molecular detail.

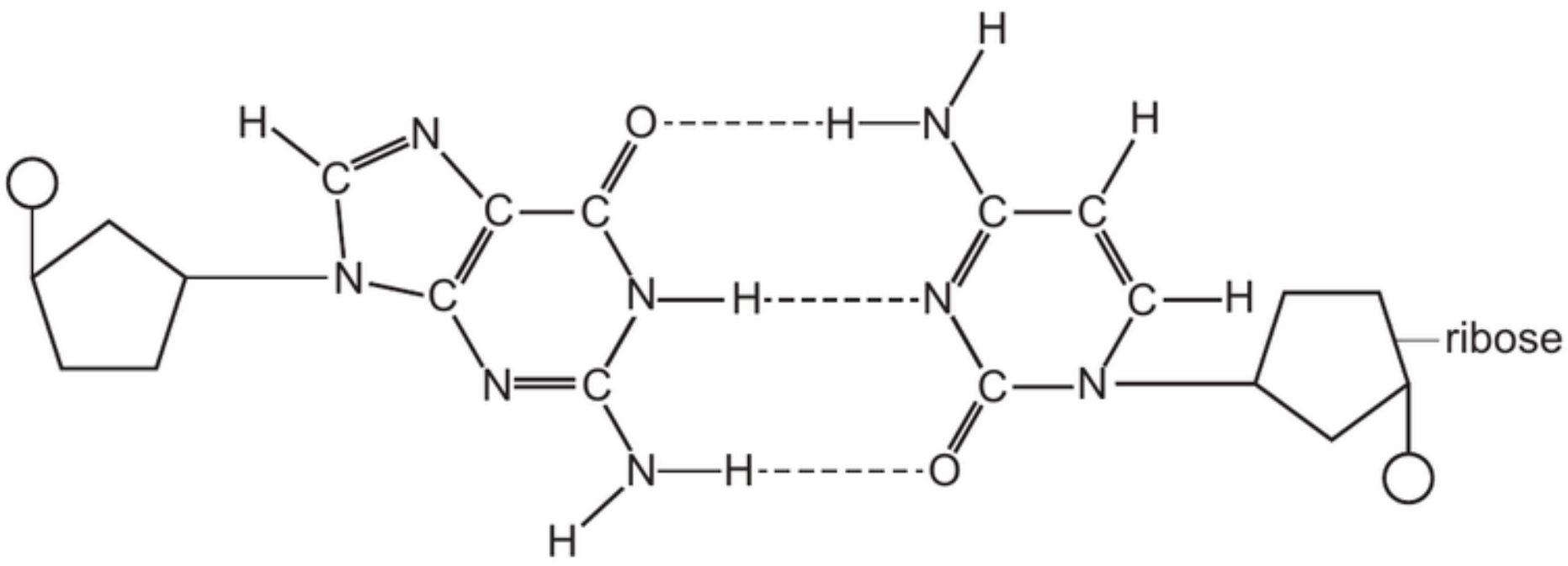

Fig. 3.1

(a) Explain why Fig. 3.1 does **not** include any phosphodiester bonds.

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..... [1]

(b) Identify **and** describe the DNA-RNA nucleotide pair shown in Fig. 3.1.

You may add labels and annotations to Fig. 3.1 if you wish.

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..... [4]

[Total: 5]

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Question No 10 - (9700_w24_22_4)

Subsection Topics: (a) : 5.1 - Replication and division of nuclei and cells | (b) : 5.1 - Replication and division of nuclei and cells | (c) : 6.1 - Structure of nucleic acids and replication of DNA | (d) : 5.1 - Replication and division of nuclei and cells | (e) : 11.1 - The immune system | (f) : 11.2 - Antibodies and vaccination | (g) : 11.1 - The immune system

Adult stem cells are undifferentiated cells that are found in most animal tissues.

Adult stem cells can divide by mitosis throughout their lifespan to form identical stem cells (self-renewal) or to form cells that can differentiate into the functioning cells of that tissue.

(a) Mitosis is important for the repair of tissues.

Explain what is meant by repair of tissues.

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..... [1]

(b) Uncontrolled cell division is a characteristic feature of tumour formation from a differentiated cell.

Describe **other** features of tumour formation from a fully differentiated cell.

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..... [2]

(c) Telomeres prevent loss of genes.

Adult stem cells have chromosomes with long telomeres.

Explain why long telomeres are an advantage to cells that carry out many cell cycles.

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..... [2]

Haematopoietic stem cells (HSCs) are adult stem cells that are located in the bone marrow of bones. HSCs have a role in the formation of blood cells.

Fig. 4.1 is an outline summary showing the formation of some of the different types of blood cell that can be formed from HSCs. The first stage is the division of HSCs to produce progenitor cells. These cells are also able to divide by mitosis, but are **not** stem cells.

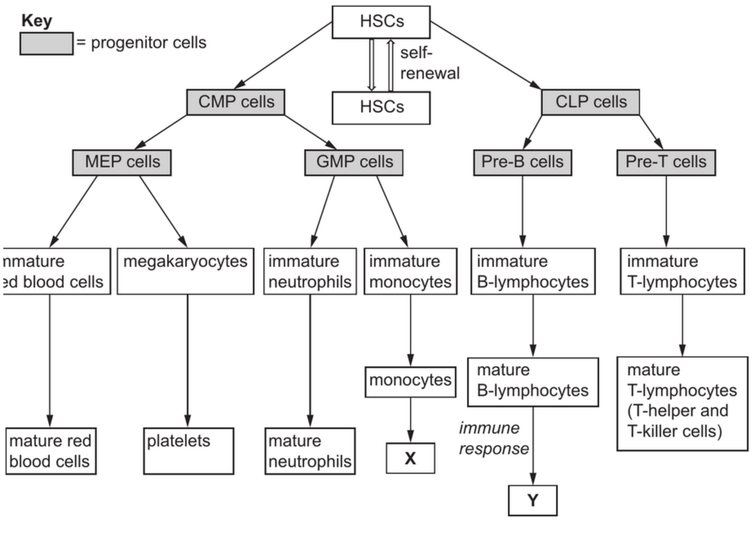

Fig. 4.1

(d) With reference to Fig 4.1, explain why GMP cells, which are progenitor cells, **cannot** be described as haematopoietic stem cells (HSCs).

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..... [3]

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DO NOT WRITE IN THIS MARGIN
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(e) Fig. 4.1 shows that monocytes differentiate into cell type **X**, which has a similar function to neutrophils.

Name cell type **X**.

..... [1]

(f) Cell type **Y** shown in Fig. 4.1 releases molecules with antigen binding sites.

Name the molecules released by cell type **Y**.

..... [1]

(g) The differentiation of T-lymphocytes begins in the bone marrow and continues in an organ known as the thymus to produce fully differentiated T-helper and T-killer cells.

In the thymus, T-lymphocytes that bind to self antigens are destroyed.

Explain why T-lymphocytes that bind to self antigens need to be destroyed in the thymus.

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..... [3]

[Total: 13]

Question No 11 - (9700_w24_23_3)

Subsection Topics: (a) : 6.1 - Structure of nucleic acids and replication of DNA | (b) : 6.1 - Structure of nucleic acids and replication of DNA

The five bases found in nucleic acids are described as nitrogenous organic compounds. There are two types of base.

Fig. 3.1 shows the structure of the five bases.

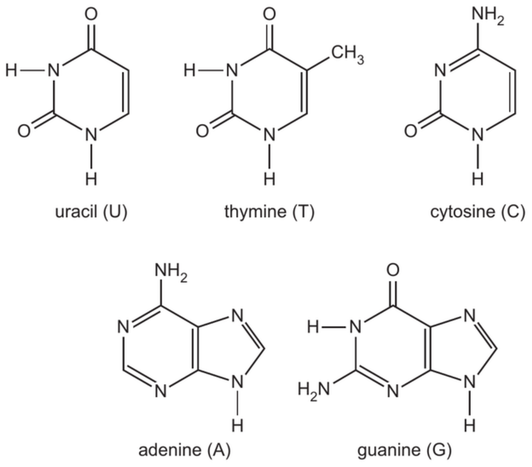

Fig. 3.1

(a) (i) State the name of the type of base that includes U, T and C.

..... [1]

(ii) State why it is **not** correct to say that all nucleic acids have five bases.

.....

..... [1]

(b) Fig. 3.2 shows a stage in the replication of DNA. The circled part is enlarged in Fig. 3.3 to show the elongation of the DNA strand that is being synthesised.

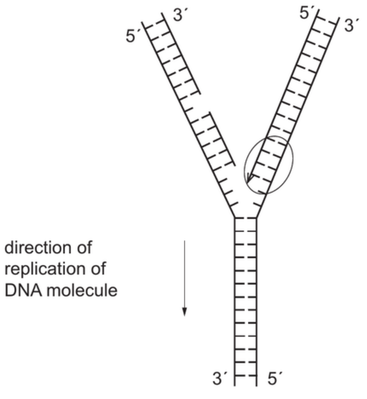

Fig. 3.2

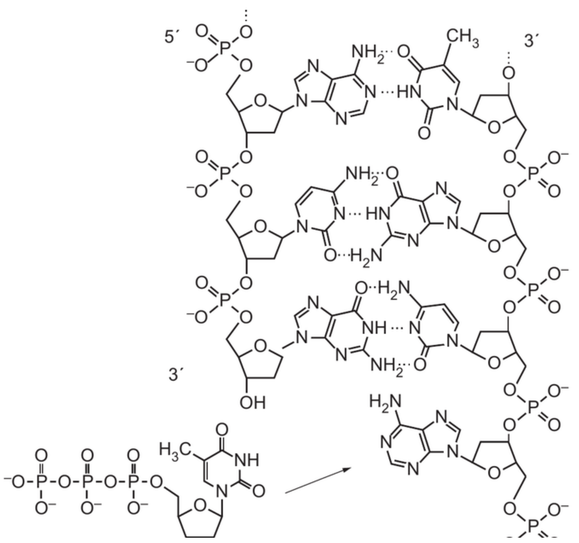

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Fig. 3.3

Describe the sequence of events that occurs at the stage shown in Fig. 3.3 to extend the synthesised strand.

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..... [4]

(c) The two strands in a molecule of DNA are described as antiparallel.

With reference to Fig. 3.2 and Fig. 3.3, state what is meant by antiparallel, **and** explain how the antiparallel arrangement of the strands determines how new strands are synthesised.

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..... [3]

[Total: 9]

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Question No 12 - (9700_m23_22_2)

Subsection Topics: (a) : 2.3 - Proteins | (b) : 2.3 - Proteins | (c) : 9.1 - The gas exchange system | (d) : 6.1 - Structure of nucleic acids and replication of DNA

(a) Cysteine is an amino acid containing sulfur. Fig. 2.1 shows the structure of the molecule formed by joining two cysteine molecules together.

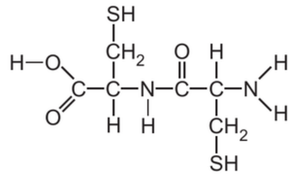

Fig. 2.1

Draw a circle around an R-group in the molecule shown in Fig. 2.1. [1]

(b) Goblet cells in the human gas exchange system produce proteins called mucins.

(i) The ends of mucin molecules contain many cysteine residues. Mucin strands are formed by joining the ends of mucin molecules together through covalent bonds between R-groups.

State the name of these covalent bonds.

..... [1]

(ii) Mucin strands are transported out of the goblet cells and then absorb water to form mucus.

Suggest **and** explain how mucin strands are transported out of the goblet cells.

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..... [3]

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Cystic fibrosis is a genetic disease caused by a mutation in the human *CFTR* gene. This results in mucus that is thicker than normal.

(c) Suggest how thicker mucus interferes with the maintenance of healthy gas exchange surfaces in the lungs.

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.....

..... [2]

(d) Row 1 and row 2 of Table 2.1 show the DNA base sequences of part of the normal *CFTR* allele and the same part of a mutated *CFTR* allele. The base sequences shown are for the DNA strands used in the synthesis of RNA. When Table 2.1 is completed, row 3 will show the base sequence of the RNA synthesised from the same part of the mutated *CFTR* allele.

Table 2.1

1	DNA base sequence of part of the normal *CFTR* allele	T	A	G	T	A	G	A	A	A	C	C	A
2	DNA base sequence of part of the mutated *CFTR* allele	T	A	G	T	A	A	C	C	A	C	A	A
3	RNA base sequence												

	synthesised from the mutated *CFTR* allele

(i) The difference between the DNA base sequence in row 1 and the DNA base sequence in row 2 of Table 2.1 is caused by a single gene mutation.

State the name of this type of gene mutation.

..... [1]

(ii) Row 1 and row 2 in Table 2.1 show the DNA strands used in the synthesis of RNA.

State the term used to describe the DNA strand that is used in the synthesis of RNA.

..... [1]

(iii) Complete Table 2.1 to show the missing bases in row 3. [1]

(iv) The normal *CFTR* allele is approximately 189 000 base pairs in length. The CFTR polypeptide consists of only 1480 amino acids.

Explain the reasons for this difference between the number of base pairs and the number of amino acids.

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..... [3]

[Total: 13]

Question No 13 - (9700_m23_22_1)

Subsection Topics: (a) : 1.2 - Cells as the basic units of living organisms | (b) : 4.1 - Fluid mosaic membranes | (c) : 5.1 - Replication and division of nuclei and cells

(a) Table 1.1 lists cell structures that can be found in eukaryotic cells or prokaryotic cells. Some of these cell structures can be found in both types of cell.

Complete the table using a tick (✓) to show that the cell structure can be present in a particular type of cell and a cross (✗) to show that the cell structure **cannot** be present.

Put a tick or a cross in every box.

The top row has been completed for you.

Table 1.1

cell structure	eukaryotic cells	prokaryotic cells
nucleus	✓	✗
Golgi body		
circular DNA		
70S ribosome		

[2]

(b) All cells have a cell surface membrane. Fig. 1.1 shows a transmission electron micrograph of part of **two** adjacent animal cells, cell 1 and cell 2.

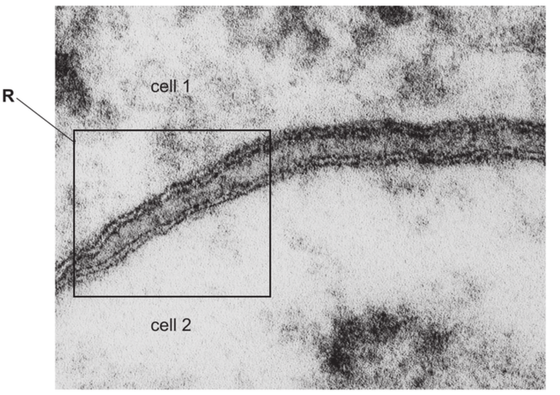

Fig. 1.1

In the space provided, draw a diagram of the region in the box labelled **R** on Fig. 1.1. Your diagram should show the four dark lines.

Label the diagram to identify what is shown by the dark lines and each of the three spaces between them.

space for diagram:

(c) Mitogens are short chains of amino acids that function as cell-signalling molecules. Mitogens are released from secretory cells and travel in the blood to target cells, where the mitogens bind to cell surface receptors. The target cells respond by progressing from the G_1 phase to the S phase of the mitotic cell cycle.

(i) Outline what happens in the G_1 phase and S phase of the mitotic cell cycle.

G_1 phase .....

.....

.....

S phase .....

.....

.....

[2]

(ii) As a result of mutation, the production and release of mitogens into the blood can be greatly increased.

Suggest a possible consequence for target cells of increased concentrations of mitogens in the blood.

.....

.....

..... [1]

[Total: 8]

Question No 14 - (9700_s23_21_4)

Subsection Topics: (a) : 6.1 - Structure of nucleic acids and replication of DNA | (b) : 6.1 - Structure of nucleic acids and replication of DNA | (c) : 5.2 - Chromosome behaviour in mitosis

The gene for the enzyme catalase is on chromosome 11 in humans.

(a) Explain the meaning of the term gene.

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..... [2]

(b) Two enzymes, DNA polymerase and DNA ligase, are involved in the replication of DNA.

Fig. 4.1 shows the replication of part of human chromosome 11 by DNA polymerase. The arrows show the direction of synthesis of the new polynucleotides by DNA polymerase.

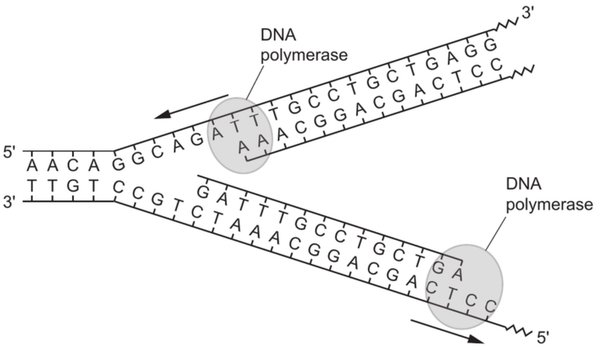

Fig. 4.1

(i) Describe the roles of DNA polymerase and DNA ligase in the replication of DNA.

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..... [5]

(ii) State the name of the stage of interphase in the cell cycle when DNA replication occurs.

..... [1]

(c) Fig. 4.2 is a diagram of chromosome 11 at metaphase of mitosis.

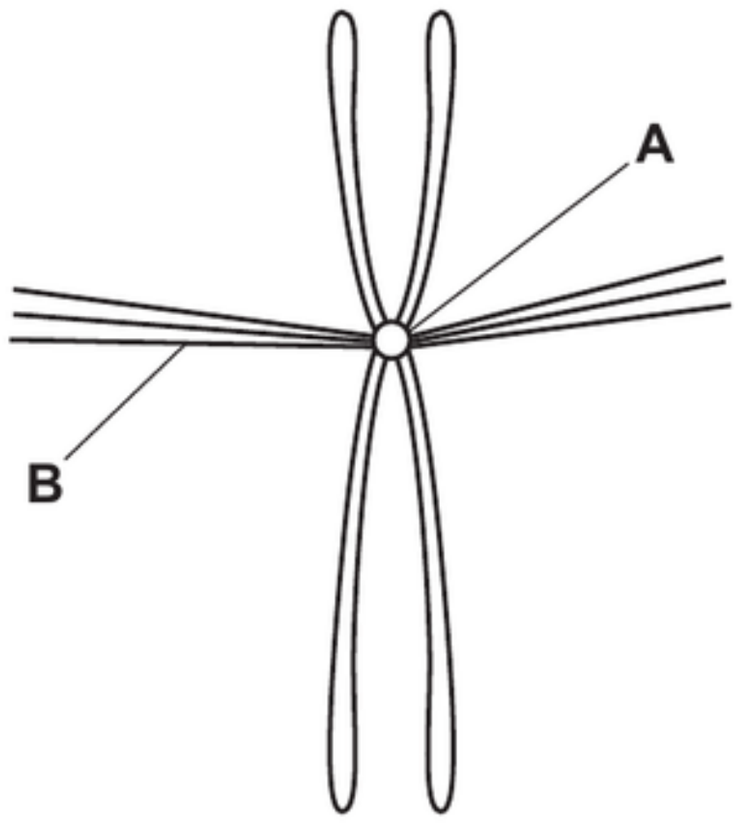


Fig. 4.2

(i) State the names **and** functions of structures **A** and **B**.

structure **A** .....

function .....

.....

structure **B** .....

function .....

.....

[2]

(ii) Complete Fig. 4.3 to show what happens to chromosome 11 in anaphase, so that the daughter nuclei are genetically identical.

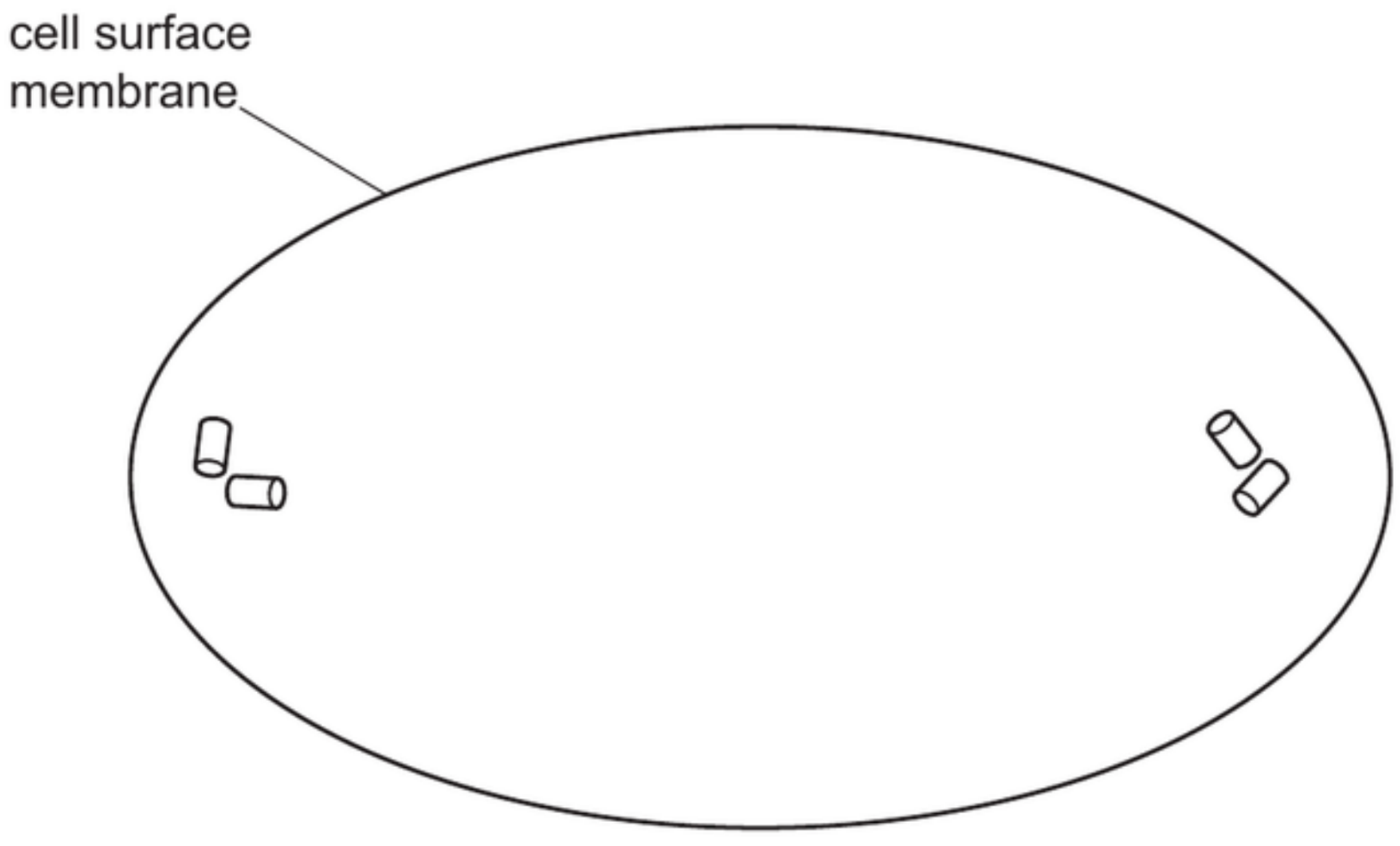


Fig. 4.3 [3]

[Total: 13]

Question No 15 - (9700_s23_22_5)

Subsection Topics: (a) : 6.1 - Structure of nucleic acids and replication of DNA | (b) : 6.1 - Structure of nucleic acids and replication of DNA

Nucleotide and nucleoside analogues are therapeutic drugs that have a similar structure to nucleotides or nucleosides of RNA and DNA.

A nucleoside is composed of a nitrogenous organic base (base) and a pentose sugar.

(a) The names of the bases present in RNA and DNA nucleotides can be abbreviated using a single letter. These are shown in Table 5.1.

Complete Table. 5.1 by stating:

- the name of each base
- whether the base is a purine **or** pyrimidine
- whether the base is present
  - **only** in an RNA molecule (write **RNA** in the table)
  - **only** in a DNA molecule (write **DNA** in the table)
  - in RNA **and** in DNA molecules (write the word **both** in the table).

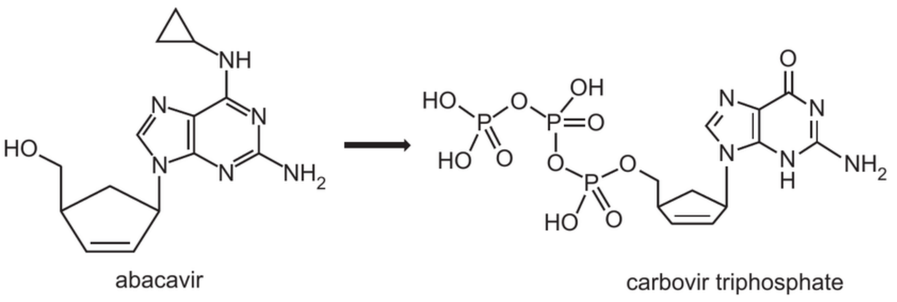
Table 5.1

base	name of base	purine or pyrimidine	present in RNA, DNA, or both
A			
C			
G			
T			
U			

[4]

(b) Abacavir is an analogue drug used in the treatment of some viral diseases. It enters a cell infected by a virus and is metabolised to the analogue carbovir triphosphate.

Fig. 5.1 shows the molecular structure of abacavir and carbovir triphosphate.



abacavir carbovir triphosphate

Fig. 5.1

Carbovir triphosphate can be inserted into an elongating polynucleotide chain instead of a nucleotide. This interferes with the action of DNA polymerase during the synthesis of viral DNA.

(i) With reference to Fig. 5.1, explain whether carbovir triphosphate will replace a purine or a pyrimidine nucleotide in the elongating polynucleotide chain.

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..... [1]

(ii) With reference to Fig. 5.1 **and** the action of DNA polymerase, suggest why the conversion of abacavir to carbovir triphosphate increases the chance of the analogue being added to the viral polynucleotide chain.

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..... [2]

(iii) Suggest **and** explain how carbovir triphosphate interferes with the action of DNA polymerase **and** how this may prevent the synthesis of viral DNA.

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..... [4]

[Total: 11]

Question No 16 - (9700_s23_22_4)

Subsection Topics: (a) : 6.2 - Protein synthesis | (b) : 10.1 - Infectious diseases | (c) : 10.1 - Infectious diseases

Trypanosoma brucei is a unicellular organism that causes the infectious disease known as sleeping sickness. Insects known as tsetse flies pass on the organism from infected people to uninfected people when male and female tsetse flies feed on human blood.

(a) Fig. 4.1 is a transmission electron micrograph of the form of *T. brucei* found in human blood.

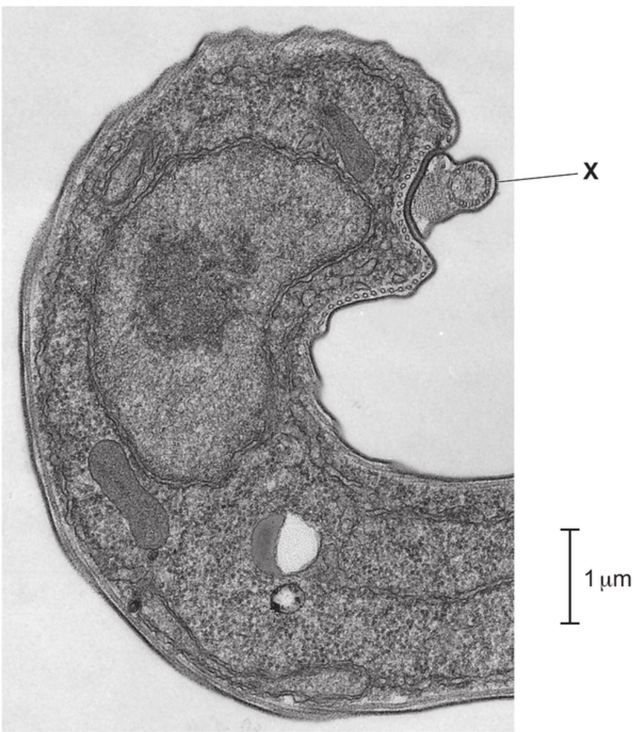

Fig. 4.1

(i) Draw an arrow on Fig. 4.1 to indicate the location in the cell where ribosomal RNA (rRNA) and proteins are assembled to make ribosomal subunits. [1]

(ii) With reference to Fig. 4.1, explain how the structure labelled **X** provides evidence that *T. brucei* is motile (able to move).

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..... [2]

(iii) With reference to Fig. 4.1, explain whether *T. brucei* is a eukaryote or prokaryote.

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..... [3]

(b) Malaria is an infectious disease caused by organisms belonging to the genus *Plasmodium*.

(i) State the term used to describe an organism that causes disease.

..... [1]

(ii) Name **one** of the species of *Plasmodium* that causes malaria.

Plasmodium ..... [1]

(c) Outline the similarities **and** differences between the modes of transmission of malaria and sleeping sickness.

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..... [3]

[Total: 11]

Question No 17 - (9700_s23_23_1)

Subsection Topics: (a) : 5.2 - Chromosome behaviour in mitosis | (b) : 6.1 - Structure of nucleic acids and replication of DNA

The cells in a tissue are often at different stages of the cell cycle.

(a) Fig. 1.1 shows cells at different stages of the cell cycle.

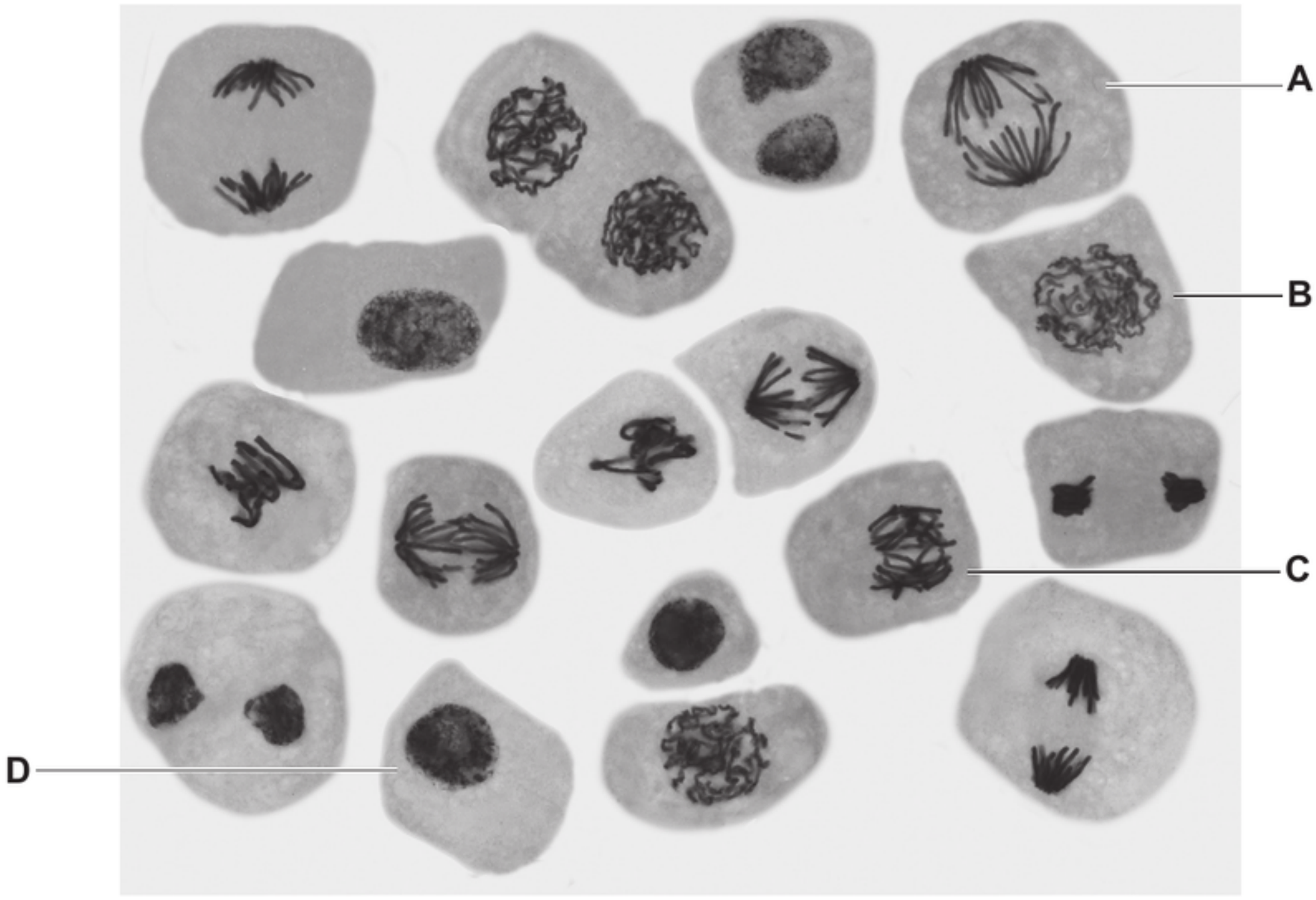

Fig. 1.1

(i) Identify the stages of mitosis occurring in the cells labelled **B** and **C** in Fig. 1.1.

B .....

C .....

[2]

(ii) Describe the behaviour of the chromosomes in the stage of mitosis shown in cell **A** in Fig. 1.1.

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..... [3]

(iii) Cell **D** in Fig. 1.1 is in interphase.

Describe the role of DNA ligase in interphase.

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..... [3]

(b) Telomerase is an enzyme that is active during interphase in some cells.

Telomerase helps to maintain telomeres present on chromosomes.

(i) State the location of telomeres on a chromosome.

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..... [1]

(ii) Some people with a long lifespan have cells showing a higher than normal activity of telomerase.

Suggest why a long lifespan could result from a higher telomerase activity.

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..... [2]

[Total: 11]

Question No 18 - (9700_s23_23_4)

Subsection Topics: (a) : 2.3 - Proteins | (b) : 7.2 - Transport mechanisms

Food crops such as barley and wheat contain gluten. Gluten contains two proteins, glutenin and gliadin.

(a) (i) Table 4.1 contains descriptions of the structures of glutenin and gliadin.

Complete Table 4.1 by writing the level of protein structure that applies to each description.

Table 4.1

description	level of protein structure
gliadin protein is a single polypeptide that forms compact structure	
)% of the amino acids in a glutenin molecule are ycine	
iadin and glutenin molecules contain regions of ·pleated sheets	

[3]

(ii) Many genes in eukaryotic cells contain introns. The genes that code for gliadin do **not** contain introns.

Explain how a lack of introns in a gliadin gene affects the production of mRNA from the primary transcript.

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..... [1]

(b) Coeliac disease is a condition in which the immune system of a person responds to gluten in their diet.

In coeliac disease, there is a response to the presence of peptides (short chains of amino acids) that are produced as a result of gliadin digestion.

(i) The gliadin peptides produced as result of digestion are often as large as 33 amino acids in length. Intestinal cells take up large numbers of these peptides at the same time.

Suggest **and** explain how gliadin peptides are transported into intestinal cells.

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..... [2]

(ii) The presence of gliadin causes the immune system of a person with coeliac disease to respond by producing anti-gliadin antibodies.

Describe the sequence of events that results in the immune system producing anti-gliadin antibodies.

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Question No 19 - (9700_w23_21_6)

Subsection Topics: (a) : 5.1 - Replication and division of nuclei and cells, 6.1 - Structure of nucleic acids and replication of DNA | (b) : 3.1 - Mode of action of enzymes

(a) (i) State the name of the phase of the mitotic cell cycle during which DNA replication occurs.

..... [1]

(ii) During research, scientists can use modified nucleotides to prevent elongation of a polynucleotide chain during DNA replication.

Fig. 6.1 shows the structure of a DNA nucleotide found in the nucleus of a cell.

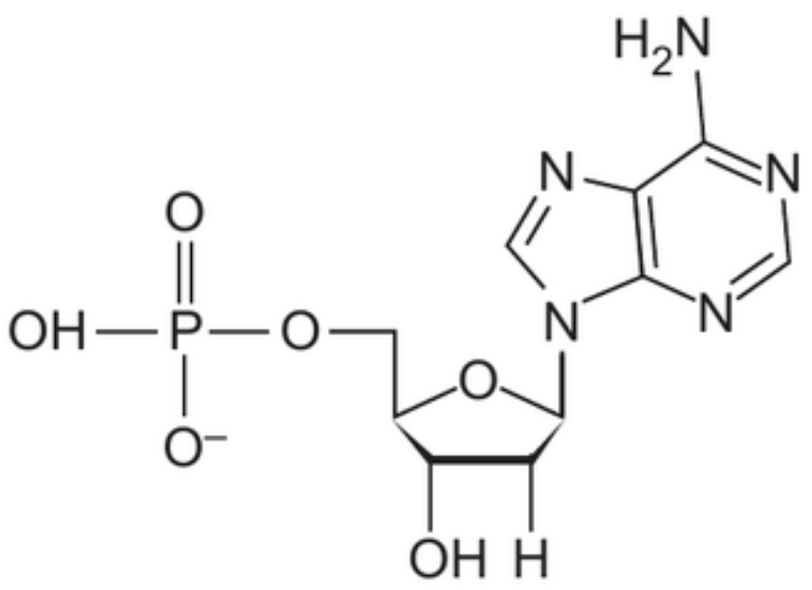

Fig. 6.1

Fig. 6.2 shows the structure of a modified nucleotide.

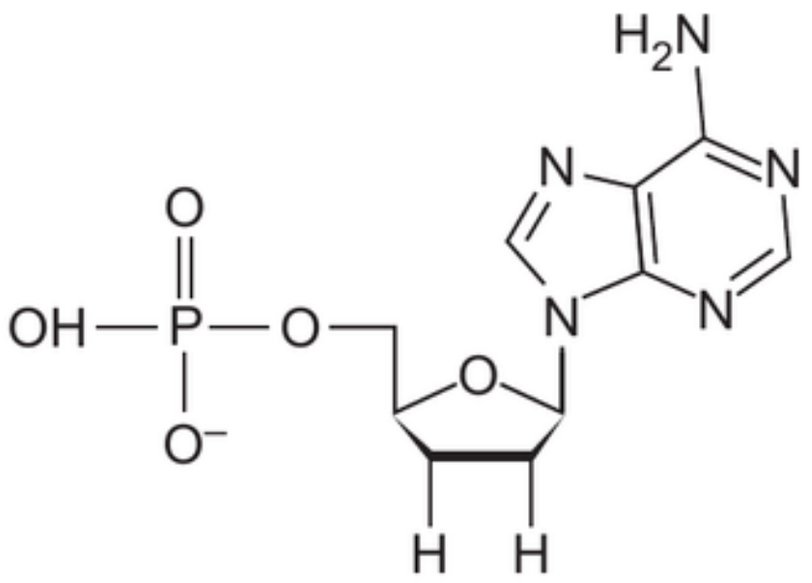

Fig. 6.2

Suggest how the structure of the modified nucleotide prevents DNA polymerase joining it to another nucleotide.

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..... [2]

(b) RNA aptamers are short, single-stranded RNA molecules that can be used to study some infectious diseases.

infectious diseases.

Scientists studying an infectious disease in animals investigated the effect of RNA aptamers on the activity of RNA polymerase that is produced by the pathogen.

The aptamers bind to a specific region of the RNA polymerase.

Table 6.1 shows the effect of two aptamers, F47 and F52, on the activity of RNA polymerase produced by the pathogen.

Table 6.1

aptamer present	V_{max} of RNA polymerase / arbitrary units	K_m of RNA polymerase / arbitrary units
none	1664	346
F47	1072	508
F52	1467	523

(i) With reference to Table 6.1, compare the effect of the aptamers on the affinity of RNA polymerase for its substrate.

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..... [2]

(ii) With reference to Table 6.1, suggest explanations for the effect of the presence of an aptamer on the rate of transcription catalysed by the RNA polymerase.

Question No 20 - (9700_w23_21_2)

Subsection Topics: (a) : 1.2 - Cells as the basic units of living organisms | (b) : 2.3 - Proteins, 2.2 - Carbohydrates and lipids, 11.1 - The immune system | (c) : 6.1 - Structure of nucleic acids and replication of DNA, 6.2 - Protein synthesis

Fig. 2.1 is a transmission electron micrograph showing a section of a specialised epithelial cell found in the lining of the stomach. This cell produces extracellular proteins that are released into the bloodstream.

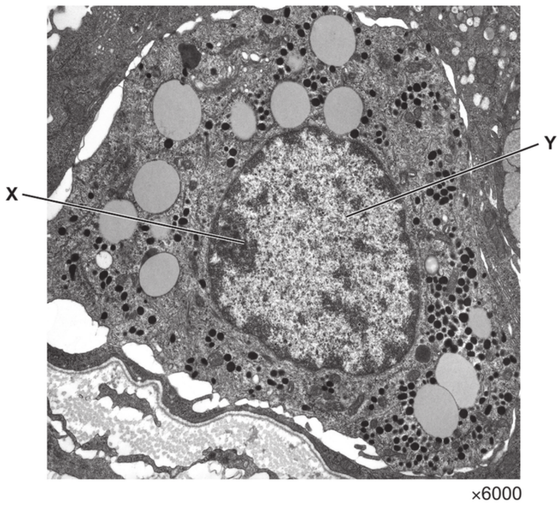

Fig. 2.1

(a) Outline the role of structure **X** and structure **Y**, as shown in Fig. 2.1, in the production of extracellular proteins.

structure **X** .....

.....

.....

structure **Y** .....

.....

.....

[2]

(b) The cell in Fig. 2.1 releases ghrelin, a small protein that acts as a cell signalling molecule.

Fig. 2.2 shows the sequence of amino acids in a ghrelin molecule.

The amino acid serine (Ser) in position 3 in Fig. 2.2 has been modified by the addition of a saturated fatty acid chain.

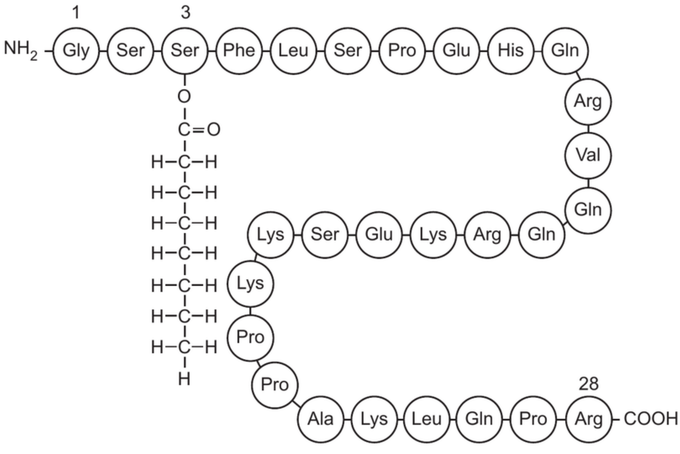

Fig. 2.2

(i) State the level of protein structure shown in Fig. 2.2.

..... [1]

(ii) State **one** similarity between the structure of a saturated fatty acid molecule and an amino acid molecule.

.....

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..... [1]

(iii) The addition of the fatty acid chain allows ghrelin to function as a cell signalling molecule.

Suggest how the addition of this fatty acid chain allows a ghrelin molecule to act as a cell signalling molecule.

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..... [3]

(c) Scientists have discovered that the gene coding for ghrelin contains 5000 base pairs. This is a much larger number of base pairs than is needed to code for the ghrelin molecule shown in Fig. 2.2.

(i) Calculate the percentage of base pairs found in the gene that codes for the ghrelin molecule shown in Fig. 2.2.

Show your working and give your answer to one decimal place.

..... [2]

(ii) The primary transcript produced from the ghrelin gene is a longer molecule than the mRNA found in the cytoplasm.

Explain how the primary transcript is modified before translation.

Question No 21 - (9700_w23_22_1)

Subsection Topics: (a) : 6.1 - Structure of nucleic acids and replication of DNA | (b) : 5.2 - Chromosome behaviour in mitosis | (c) : 5.2 - Chromosome behaviour in mitosis

During interphase and mitosis of the cell cycle, the chromosomes within a cell go through a number of changes. Each chromosome is composed of DNA complexed with proteins.

(a) In interphase, individual chromosomes are too diffuse (long and thin) to be visible using a microscope. In this stage, the chromosomal material is known as chromatin.

State the term used to describe the proteins that are complexed with DNA and form part of chromatin.

..... [1]

(b) When viewed through a microscope, a chromosome is most clearly visible during the metaphase stage of mitosis.

Complete Fig. 1.1 to produce a labelled diagram of the metaphase stage of mitosis in an **animal** cell with **two** chromosomes.

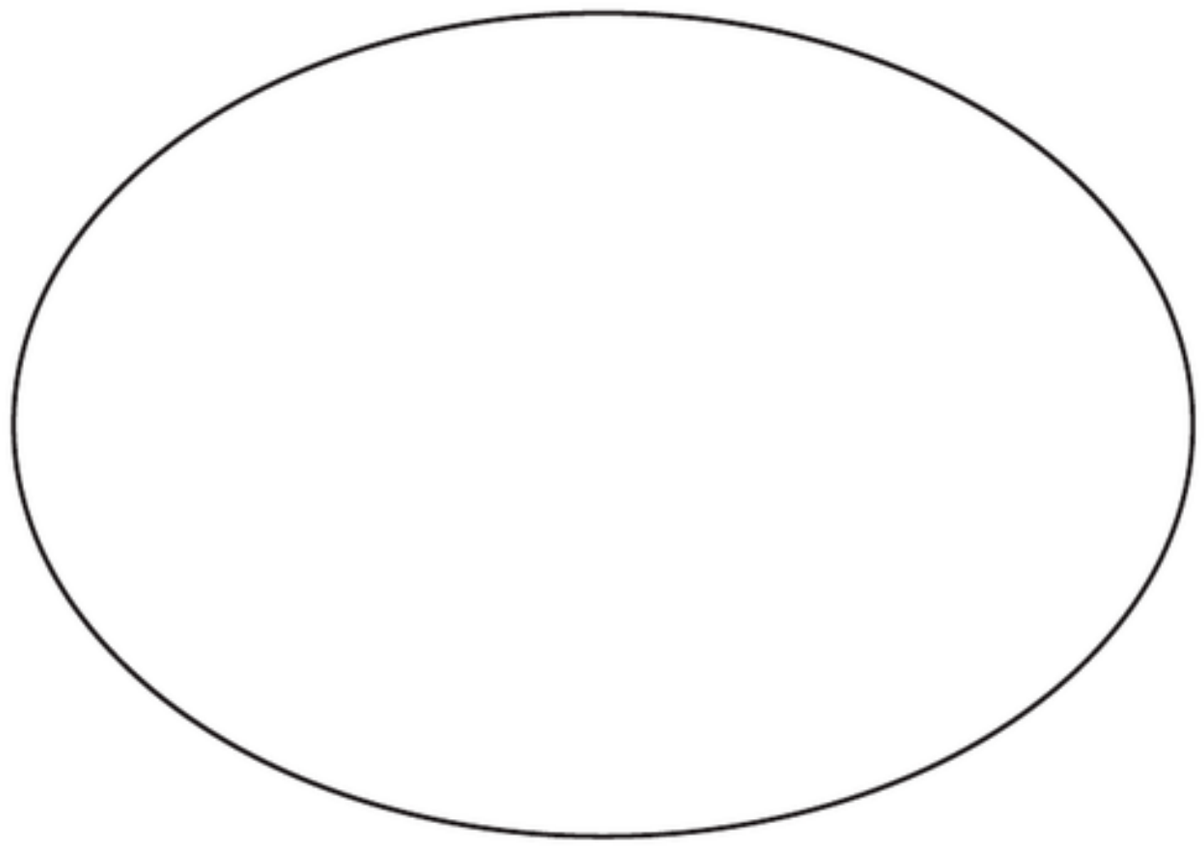

Fig. 1.1

[3]

(c) Outline the changes that occur to the structure and behaviour of a chromosome:

- from the start of the S phase to the end of interphase
- during prophase of mitosis.

Question No 22 - (9700_w23_22_4)

Subsection Topics: (a) : | (b) : | (c) : 6.2 - Protein synthesis | (d) : 6.2 - Protein synthesis

The alveoli of the lungs are the main gas exchange surface in humans.

(a) Explain how blood flow through the alveolar capillaries helps to maintain steep diffusion gradients for gas exchange.

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..... [2]

(b) Ventilation of the lungs is the process of inhalation and exhalation. Ventilation helps to maintain steep diffusion gradients.

Explain the role of elastic fibres in the alveolar wall during ventilation.

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..... [2]

(c) Some cells in the alveolar wall are specialised to secrete surfactant to prevent collapse of the alveoli at the end of exhalation. In these cells, surfactant is stored in membrane-bound organelles known as lamellar bodies. Surfactant is a mixture of lipids, mainly phospholipids, and some proteins.

A protein known as ATP-binding cassette transporter A3 (ABCA3) is needed to move surfactant phospholipids into lamellar bodies from the surrounding cytosol (fluid part of cytoplasm).

Suggest **and** explain the features of protein ABCA3 that make it suited to its function.

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..... [3]

(d) The gene *ABCA3* codes for protein ABCA3. The gene is 80 kb (80 000 base pairs) long and is composed of introns and exons. Protein ABCA3 is composed of 1704 amino acids.

(i) Fig. 4.1 shows the flow of genetic information in the production of ABCA3.

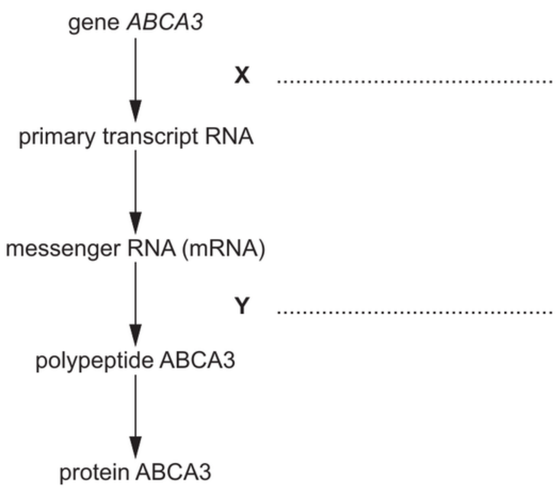

Fig. 4.1

Complete Fig. 4.1 to name the processes occurring at **X** and **Y**. [2]

(ii) A triplet of bases codes for one amino acid. This fact only partly explains how the activity of gene *ABCA3*, which is 80 kb long, can result in the protein ABCA3, which is only 1704 amino acids long.

Suggest **other** reasons to explain the difference in the number of base pairs in gene *ABCA3* compared with the number of amino acids in protein ABCA3.

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..... [3]

[Total: 12]

Question No 23 - (9700_w23_22_3)

Subsection Topics: (a) : 8.1 - The circulatory system | (b) : 4.2 - Movement into and out of cells, 11.1 - The immune system | (c) : 1.2 - Cells as the basic units of living organisms, 6.2 - Protein synthesis, 2.3 - Proteins

The liver receives blood from the hepatic artery and from the hepatic portal vein. The hepatic portal vein transports blood from the digestive system.

Hepatocytes are the main cell type of the liver. They have a wide range of functions, including:

- the synthesis of triglycerides and plasma proteins
- detoxifying waste
- energy storage.

(a) The hepatic artery branches from the main artery that transports blood from the heart.

Name the main artery that transports blood to the hepatic artery.

..... [1]

(b) Blood arriving at the liver enters specialised blood vessels known as sinusoids.

Fig. 3.1 is a diagram of part of a sinusoid and surrounding hepatocytes. A second type of cell found in the liver, a Kupffer cell, is also shown.

Kupffer cells are phagocytic cells of the immune system.

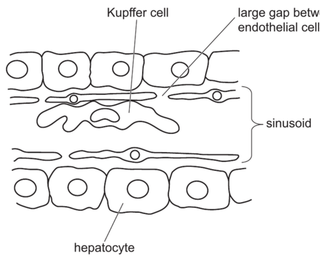

Fig. 3.1

(i) Suggest **one** advantage of having large gaps between the endothelial cells of the sinusoid, as shown in Fig. 3.1.

.....

.....

..... [1]

(ii) In addition to removing bacteria present in the blood inside the sinusoid, Kupffer cells are also able to remove old or damaged red blood cells.

Describe the mode of action of a Kupffer cell in removing and breaking down a damaged red blood cell.

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..... [4]

(c) Fig. 3.2 is a transmission electron micrograph of part of a hepatocyte showing some cell structures.

The peroxisome shown in Fig. 3.2 is a spherical organelle bound by a single membrane. It carries out a variety of enzyme-catalysed metabolic reactions, including detoxification. Some of these reactions require oxygen.

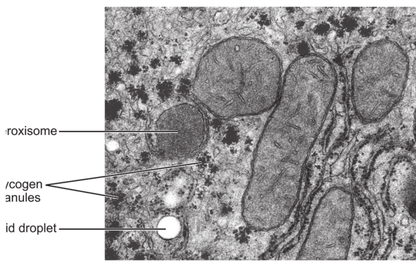

Fig. 3.2

(i) Describe the evidence **visible** in Fig. 3.2, apart from the presence of a peroxisome, that indicates some of the functions of a hepatocyte.

Add labels to Fig. 3.2 to identify the location of any cell structures, if not already labelled, that are part of your evidence.

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..... [3]

(ii) The mitochondria in Fig. 3.2 are larger than the peroxisome.

State **one other** difference, **visible** in Fig. 3.2, between a peroxisome and a mitochondrion.

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..... [1]

(iii) Some of the enzymes used within mitochondria can be synthesised by the organelle. Peroxisomes cannot synthesise any of the enzymes that they contain.

Suggest why a mitochondrion can synthesise enzymes, but a peroxisome cannot synthesise enzymes.

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..... [2]

(iv) One of the enzymes present in peroxisomes is catalase. This enzyme catalyses the breakdown of hydrogen peroxide to harmless products.

Suggest why it is useful to the cell for this reaction to take place within peroxisomes.

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.....

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..... [2]

[Total: 14]

Question No 24 - (9700_w23_23_4)

Subsection Topics: (a) : 6.2 - Protein synthesis | (b) : 6.1 - Structure of nucleic acids and replication of DNA, 6.2 - Protein synthesis | (c) : 1.2 - Cells as the basic units of living organisms, 1.1 - The microscope in cell studies | (d) : 4.2 - Movement into and out of cells

Fig. 4.1 is a diagram showing the transcription of part of the *COL1A2* gene that codes for a collagen polypeptide. The part of the *COL1A2* gene shown is a section of exon. Structure **A** represents an enzyme involved in transcription.

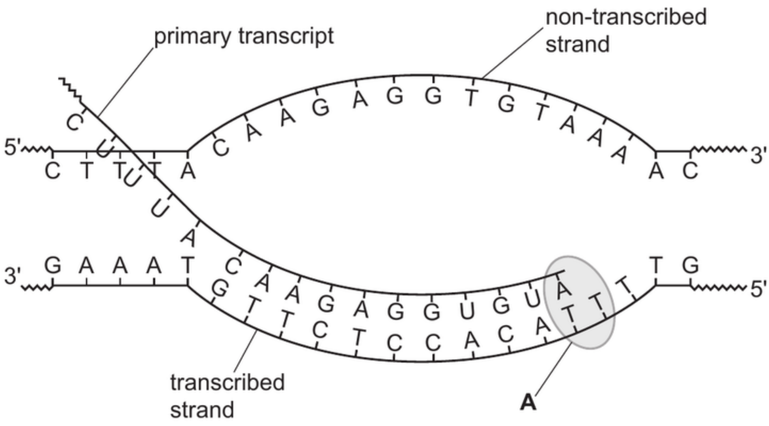

Fig. 4.1

(a) **(i)** Name the enzyme labelled **A** in Fig. 4.1.

..... [1]

(ii) Name the bond that forms between the nucleotides in the primary transcript.

..... [1]

(b) **(i)** State the number of amino acids that are coded for by the sequence of nucleotides on the primary transcript shown in Fig. 4.1.

..... [1]

(ii) Use the information in Fig. 4.1 to explain why one of the strands of DNA is **not** transcribed.

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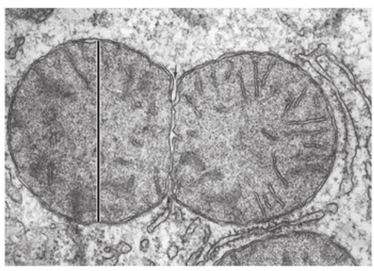
..... [2]

(c) New mitochondria are formed when a mitochondrion divides into two.

Fig. 4.2 is a transmission electron micrograph of a mitochondrion that is dividing.



magnification ×50 000

Fig. 4.2

(i) State **two** features of mitochondria that are **visible** in Fig. 4.2.

1 .....

2 .....

[2]

(ii) The line on Fig. 4.2 shows the diameter of one of the mitochondria.

Calculate the actual diameter of the mitochondrion.

Give your answer to one significant figure.

answer = ... μm [1]

(d) Mitochondrial DNA codes for some polypeptides of proteins used within the mitochondrion. Some of the proteins allow movement of ions into and out of the mitochondria.

Outline the ways in which ions can move into mitochondria.

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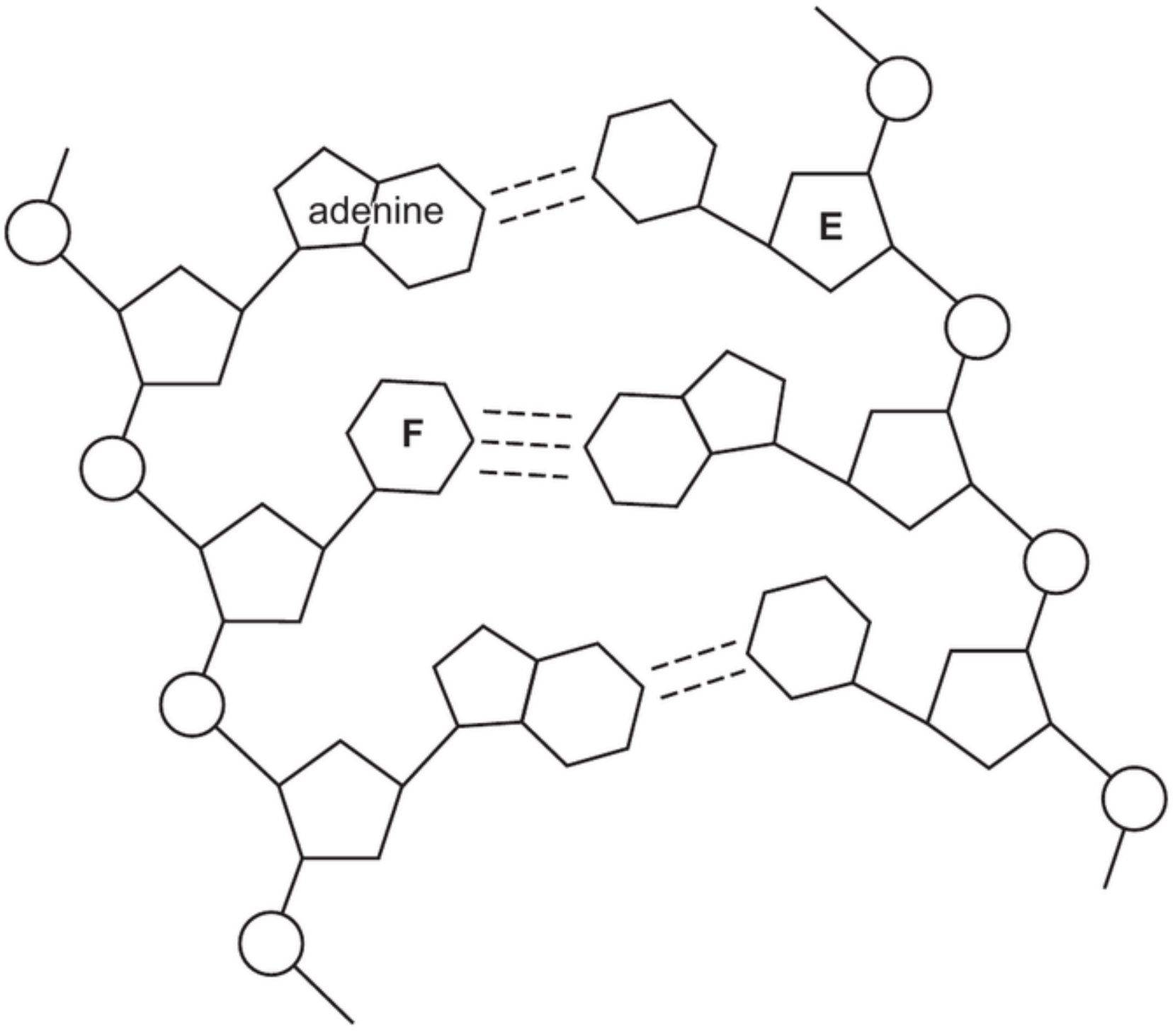
..... [3]

[Total: 11]

Question No 25 - (9700_m22_22_6)

Subsection Topics: (a) : 6.1 - Structure of nucleic acids and replication of DNA | (b) : 6.1 - Structure of nucleic acids and replication of DNA | (c) : 6.1 - Structure of nucleic acids and replication of DNA | (d) : 6.2 - Protein synthesis

Fig. 6.1 is a diagram showing the structure of part of a DNA molecule.



key

---- one hydrogen bond

Fig. 6.1

(a) (i) Identify structure **E** and structure **F** in Fig. 6.1.

E .....

F .....

[2]

(ii) On Fig. 6.1 draw a circle around **one** nucleotide. [1]

(iii) State the name of the covalent bond that links two nucleotides together.

..... [1]

(b) Fig. 6.2 shows the RNA base sequence of a short length of primary transcript.

Complete Fig. 6.2 by writing the DNA base sequence of the template strand used to form the primary transcript.

DNA base sequence used to form the primary transcript				
primary transcript	G G U	G C U	A A U	C U A

Fig. 6.2

[1]

(c) In eukaryotic cells, the primary transcript is modified to form mRNA.

Explain how the primary transcript is modified to form mRNA.

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..... [2]

(d) The mRNA strand is translated at the ribosome to form a polypeptide.

Describe how the process of translation results in the formation of a polypeptide.

Question No 26 - (9700_m22_22_2)

Subsection Topics: (a) : 5.2 - Chromosome behaviour in mitosis | (b) : 6.1 - Structure of nucleic acids and replication of DNA | (c) : 5.1 - Replication and division of nuclei and cells

(a) Fig. 2.1 shows a cell at one of the main stages of mitosis in the mitotic cell cycle.

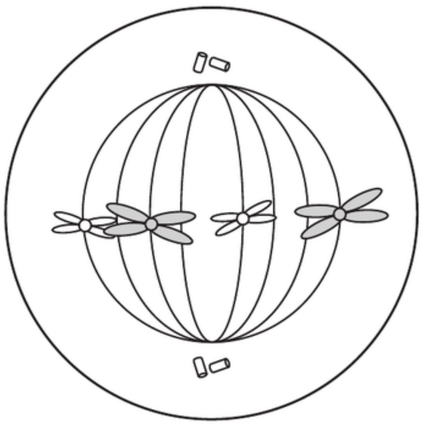

Fig. 2.1

(i) Name the stage of mitosis shown in Fig. 2.1.

..... [1]

(ii) Fig. 2.2 shows the cell in Fig. 2.1 at the start of cytokinesis.

Complete Fig. 2.2 to show the daughter chromosomes in each nucleus.

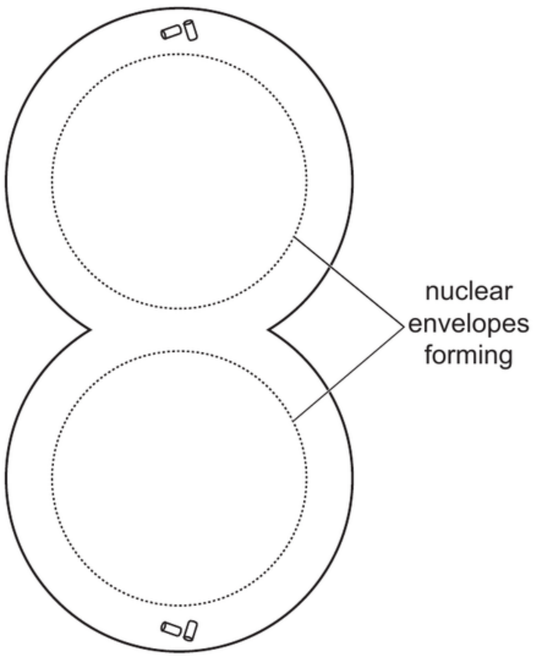

Fig. 2.2

[2]

(b) State the role of telomeres during DNA replication.

.....

.....

..... [1]

(c) Multiple myeloma is a type of cancer in the bone marrow where some of the stem cells start to produce abnormal blood cells.

- One treatment is to collect stem cells from the bone marrow of the person with multiple

- One treatment is to collect stem cells from the bone marrow of the person with multiple myeloma. Healthy stem cells are isolated and grown in the laboratory.
- Radiation is then used to destroy all stem cells and cancerous cells in the bone marrow.
- Finally, large numbers of the healthy stem cells grown in the laboratory are returned to the bone marrow.

Suggest the role of stem cells in this treatment of multiple myeloma.

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..... [3]

[Total: 7]

Question No 27 - (9700_s22_21_6)

Subsection Topics: (a) : 6.1 - Structure of nucleic acids and replication of DNA | (b) : 6.1 - Structure of nucleic acids and replication of DNA | (c) : 6.2 - Protein synthesis

Cotransporter proteins are membrane proteins found in companion cells of phloem tissue.

Messenger RNA (mRNA) is the molecule in cells that carries genetic information in the DNA that codes for cotransporter proteins to the sites of protein synthesis in the cytoplasm.

(a) Complete Table 6.1 to compare the structure of a molecule of mRNA with the structure of a molecule of DNA.

Table 6.1

feature	mRNA	DNA
names of four bases		
name of pentose sugar present		
number of strands		

[3]

(b) Fig. 6.1 shows the events that occur in the nucleus of a companion cell in phloem tissue to synthesise molecules of mRNA.

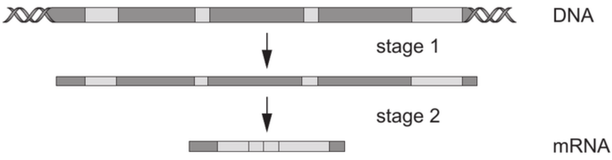

Fig. 6.1

(i) Name stage 1 shown in Fig. 6.1.

..... [1]

(ii) Describe what happens at stage 2, shown in Fig. 6.1, to shorten the length of the RNA molecule.

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..... [2]

(c) Cotransporter molecules are proteins produced in companion cells.

Fig. 6.2 shows what happens in the cytoplasm of a companion cell to a transfer RNA molecule before the cotransporter proteins can be produced.

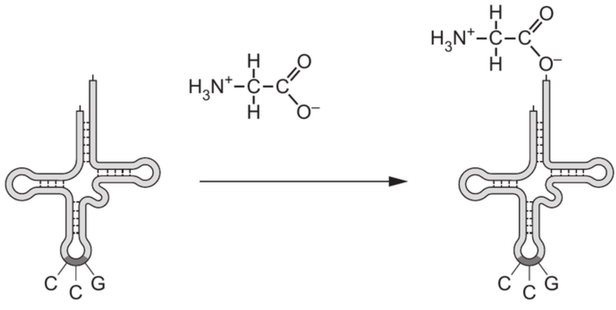

Fig. 6.2

(i) Describe the role of the transfer RNA shown in Fig. 6.2 in the synthesis of a cotransporter protein.

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..... [4]

(ii) Outline the role of cotransporter proteins in companion cells.

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..... [3]

[Total: 13]

Question No 28 - (9700_s22_22_4)

Subsection Topics: (a) : 8.2 - Transport of oxygen and carbon dioxide | (b) : 3.1 - Mode of action of enzymes | (c) : 6.1 - Structure of nucleic acids and replication of DNA | (d) : 8.2 - Transport of oxygen and carbon dioxide | (e) : 7.2 - Transport mechanisms | (f) : 3.2 - Factors that affect enzyme action

The enzyme carbonic anhydrase has been found in a wide range of organisms and acts as a catalyst in many tissues.

Studies have shown that there are differences in the protein structure of the enzyme and differences in the number and organisation of introns and exons of the gene coding for the enzyme.

All carbonic anhydrase enzymes catalyse the same reversible reaction, shown in Fig. 4.1.

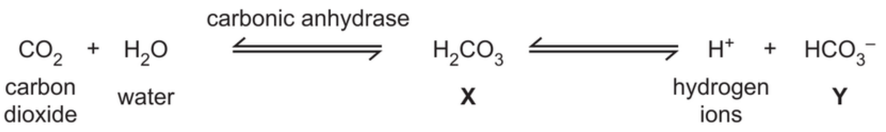

Fig. 4.1

(a) With reference to Fig. 4.1, name **X** and **Y**.

X .....

Y .....
[2]

(b) Carbonic anhydrase enzymes can have different primary structures.

Suggest how all carbonic anhydrase enzymes can catalyse the same reaction, even though they have different primary structures.

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.....

..... [1]

(c) Genes coding for proteins in eukaryotes consist of introns and exons.

Outline the similarities and differences between the introns and the exons of genes coding for proteins such as carbonic anhydrase.

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..... [3]

All mammals have the same type of carbonic anhydrase, known as α-carbonic anhydrase. Many different forms, or isoforms, of α-carbonic anhydrase have been identified in mammals.

There are 15 isoforms of α-carbonic anhydrase (CA) in humans. Cells of different tissues have one or more isoforms. Within cells the isoforms may be in different locations.

(d) Red blood cells contain two isoforms, CA1 and CA2.

Suggest the location of CA1 and CA2 in red blood cells **and** give a reason for your answer.

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..... [2]

(e) Isoform CA6 forms part of human breast milk. Mammary gland cells package CA6 in Golgi vesicles for release from the cells.

Name the transport mechanism associated with CA6 secretion.

..... [1]

(f) Human CA isoforms in some epithelial cells in the eye have a role in the formation of the clear fluid of the eye known as aqueous humour. Overactivity of the enzyme may lead to a harmful increase of pressure within the eye and cause a condition known as glaucoma.

Acetazolamide is a therapeutic drug that can be used in the treatment of glaucoma. It acts as a reversible non-competitive inhibitor.

Describe the mechanism of action of acetazolamide as a reversible non-competitive inhibitor of carbonic anhydrase.

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..... [3]

[Total: 12]

Question No 29 - (9700_s22_23_4)

Subsection Topics: (a) : 1.1 - The microscope in cell studies | (b) : 10.1 - Infectious diseases | (c) : 10.1 - Infectious diseases | (d) : 6.1 - Structure of nucleic acids and replication of DNA | (e) : 11.2 - Antibodies and vaccination

There are many different forms of *Vibrio cholerae*, a bacterium that is found naturally in aquatic environments. The bacterium is motile (can move) and uses a cell structure known as a flagellum to allow it to move through water.

Fig. 4.1 is a drawing of four cells of one form of *V. cholerae*.

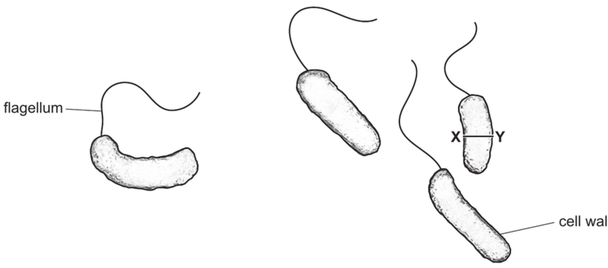

Fig. 4.1

Two main forms of *V. cholerae*, O1 and O139, are able to colonise the small intestine and cause cholera. These two forms are able to produce a toxin, choleragen, which causes the symptoms of diarrhoeal disease. Mutant *V. cholerae* that lack flagella are less able to cause disease.

(a) The magnification of the diagram shown in Fig. 4.1 is ×32 000.

Calculate the actual width **X–Y** in Fig. 4.1 in nanometres (nm) **and** give your answer to the nearest 10 nm.

Complete Fig. 4.2 to show the formula you will use to make your calculation.

actual width	=

Fig. 4.2

answer = ... nm [2]

(b) State the term used to describe disease-causing organisms, such as the bacterium *V. cholerae*.

..... [1]

(c) Outline **one** way in which an uninfected person may become infected by *V. cholerae*.

.....

.....

..... [1]

(d) Choleragen is produced after *V. cholerae* has penetrated (passed through) the mucus lining and attached to intestinal epithelial cells.

Choleragen is composed of two subunits:
- subunit **A** consists of one polypeptide
- subunit **B** consists of five identical polypeptides
- the polypeptide in subunit **A** is different from the polypeptides in subunit **B**.

Two genes, *ctxA* and *ctxB*, are needed to produce choleragen. Only one strand of the DNA forming gene *ctxA* is involved in the production of subunit **A**. Only one strand of the DNA forming gene *ctxB* is involved in the production of subunit **B**.

Explain why only one strand of the DNA of each gene is involved in the production of the subunits.

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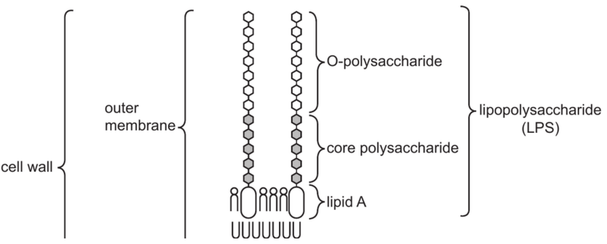
..... [3]

Monoclonal antibodies (mAbs) can be designed to act against components of the cell wall of *V. cholerae*. The cell wall has an outer membrane with lipopolysaccharide (LPS) molecules, shown in Fig. 4.3.



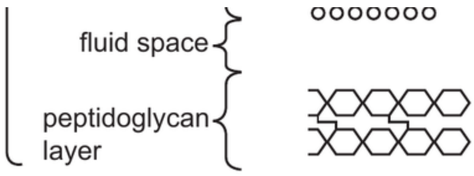


Fig. 4.3

The core polysaccharide and the lipid A components of the LPS molecules are the same in *V. cholerae* O1 and *V. cholerae* O139. However they have different O-polysaccharides.

There are also different types of *V. cholerae* O1 and these have different O-polysaccharides.

(e) Laboratory tests were carried out using two different monoclonal antibodies that had been designed and produced to act against the LPS of bacterial cultures of *V. cholerae* O1:

- mAb 2D6 acts against the O-polysaccharide
- mAb ZAC-3 acts against the core polysaccharide and lipid A components.

(i) Explain why the mAb ZAC-3 produced against the core polysaccharide and lipid A components will not act against the O-polysaccharide of the LPS molecules.

.....

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..... [2]

(ii) The results of the tests showed that both mAbs were effective in causing agglutination (clumping) of bacteria and in preventing their motility. This suggests they may be useful for preventing cholera and for treating the disease.

Discuss whether mAb 2D6 and mAb ZAC-3 may be useful for preventing cholera **and** for treating the disease.

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..... [4]

[Total: 13]

Question No 30 - (9700_s22_23_5)

Subsection Topics: (a) : 4.1 - Fluid mosaic membranes | (b) : 3.2 - Factors that affect enzyme action | (c) : 6.1 - Structure of nucleic acids and replication of DNA | (d) : 4.1 - Fluid mosaic membranes

Arachidonic acid is a fatty acid that is a common component of phospholipids.

Phospholipids can be used as a source of arachidonic acid when it is metabolised within cells in an enzyme-catalysed pathway known as the cyclooxygenase (COX) pathway.

The final products of the COX pathway can be different in different cell types, causing a range of responses. In some cells, the products are involved in the inflammatory response, which is a response by the body to infection. In other cells, cell division is stimulated.

Fig. 5.1 shows the **first reaction** in the COX pathway. This reaction is catalysed by an enzyme known as COX-2.

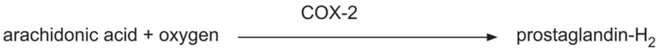

Fig. 5.1

(a) The enzymes involved in the COX pathway are located in the membrane of rough endoplasmic reticulum.

Suggest the advantages to the cell of enzyme pathways being located in cell membranes, rather than in the cytosol of the cell (fluid portion of cytoplasm).

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..... [2]

(b) During an inflammatory response, compounds produced by the COX pathway cause an increased sensitivity to pain.

Some anti-inflammatory drugs are reversible competitive inhibitors of COX-2.

Fig. 5.2 shows how increasing arachidonic acid concentration affects COX-2 activity.

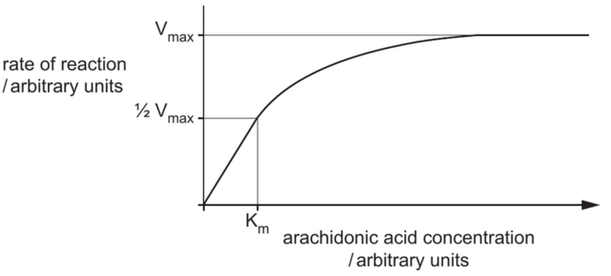

Fig. 5.2

(i) Sketch on Fig. 5.2 the curve obtained if an anti-inflammatory drug, which is a **competitive** inhibitor, is present with arachidonic acid. [1]

(ii) Complete the statements to show whether the maximum rate of reaction (V_{max}) and the Michaelis-Menten constant (K_m) of COX-2 **increases**, **decreases**, or **stays the same** in the presence of a competitive inhibitor.

In the presence of a competitive inhibitor:

V_{max} of COX-2 .....

K_m of COX-2 ..... . [2]

(c) COX-2 is composed of two identical polypeptides. The enzyme is produced when a gene, *PTGS2*, located on chromosome 1, is switched on and transcription begins.

(i) Using gene *PTGS2* and enzyme COX-2 as examples, explain what is meant by a gene.

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..... [2]

(ii) Some mutations in *PTGS2* lead to an increased rate of transcription. These mutations have been linked to an increased risk of certain types of cancer.

Suggest why mutations in *PTGS2* may increase the risk of cancer.

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..... [2]

(d) Fig. 5.3 shows the molecular structure of arachidonic acid. Not all hydrogen atoms are shown.

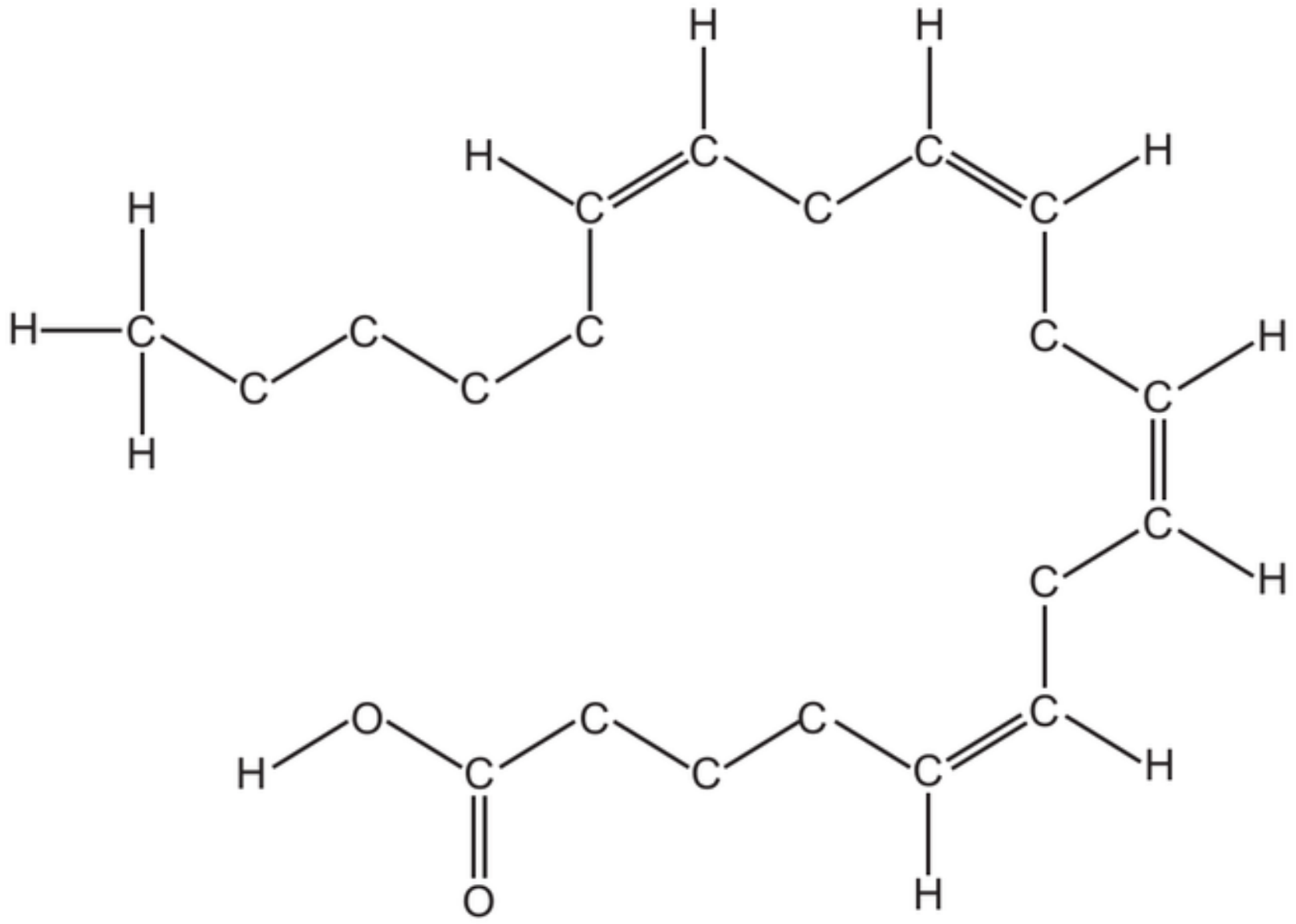

Fig. 5.3

With reference to Fig. 5.3, explain why increasing the proportion of phospholipids with arachidonic acid in a cell will increase the fluidity of the cell surface membrane of the cell.

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..... [3]

[Total: 12]

Question No 31 - (9700_w22_21_3)

Subsection Topics: (a) : 2.3 - Proteins | (b) : 6.1 - Structure of nucleic acids and replication of DNA

Carbonic anhydrase is a globular protein found in red blood cells.

(a) (i) Explain why this protein is described as globular.

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..... [2]

(ii) State the function of carbonic anhydrase in red blood cells.

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..... [2]

(b) A protein such as carbonic anhydrase is coded for by a gene. A gene forms part of a DNA molecule.

Fig. 3.1 is a diagram of a small section of a DNA molecule.

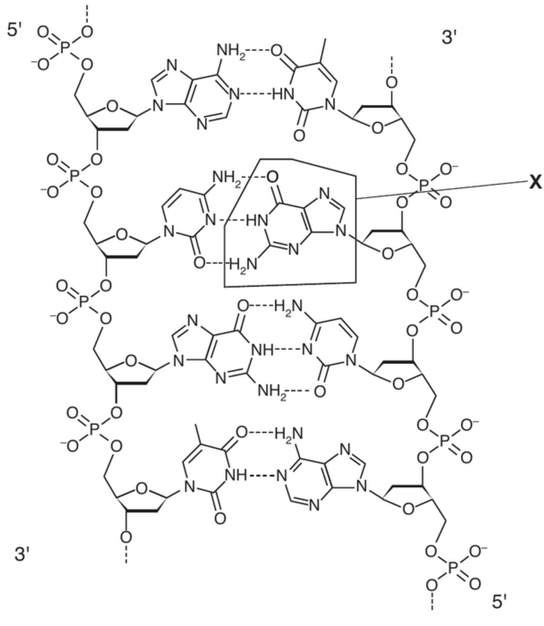

Fig. 3.1

(i) Identify the base **X and** state the evidence in Fig. 3.1 that supports this identification.

base **X** .....

evidence from Fig. 3.1 .....

.....

.....

.....

.....

[3]

(ii) The section of the DNA molecule in Fig. 3.1 is part of a gene coding for a polypeptide.

Base **X**, shown in Fig. 3.1, is located in an exon on the strand of DNA that is transcribed during protein synthesis. A mutation that results in the deletion of base **X** will affect the polypeptide produced.

Explain how this deletion may affect the polypeptide produced during protein synthesis.

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.....

..... [4]

(iii) Gene mutations can occur in either introns or exons.

Suggest the effect of a gene mutation in an intron.

.....

.....

..... [1]

[Total: 12]

Question No 32 - (9700_w22_22_2)

Subsection Topics: (a) : 6.1 - Structure of nucleic acids and replication of DNA | (b) : 1.1 - The microscope in cell studies | (c) : 6.1 - Structure of nucleic acids and replication of DNA | (d) : 1.2 - Cells as the basic units of living organisms | (e) : 6.1 - Structure of nucleic acids and replication of DNA | (f) : 5.1 - Replication and division of nuclei and cells | (g) : 11.1 - The immune system

Human cytomegalovirus (HCMV) is a common virus affecting humans. In people with a fully functioning immune system, infection by HCMV usually causes no, or only mild, symptoms.

Fig. 2.1**A** is a diagram of a section through HCMV. In Fig. 2.1**B**, only the outer part of HCMV is sectioned.

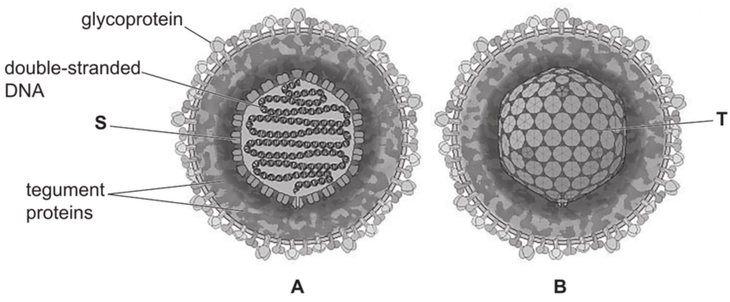

Fig. 2.1

The viral DNA shown in Fig. 2.1 contains genes that code for proteins important in viral replication and viral structure, including viral DNA polymerase and proteins known as tegument proteins.

Viruses can only replicate in host cells as they need to use processes and contents of the host cell. Complete viral particles that are released from the host cell are known as virions.

(a) Structure **S** in Fig. 2.1**A** is a subunit of structure **T** in Fig. 2.1**B**.

Name the chemical compound used to make structure **S and** name structure **T**.

S .....

T .....
[2]

(b) The actual diameter of the HCMV shown in Fig. 2.1 is 0.17 micrometres (μm).

Calculate the actual diameter of the virus in nanometres (nm).

..... [1]

(c) Suggest the role of viral DNA polymerase within the host cell.

..... [1]

-

(d) The virus in Fig. 2.1 is drawn as a spherical shape. Structure **T** is always the same shape. However, electron micrographs show that HCMV virions are not all the same shape.

Suggest how HCMV virions can be of different shapes.

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..... [2]

(e) With reference to Fig. 2.1**A**, state **one** similarity **and one** difference between the genetic material of HCMV and the genetic material of a typical bacterial cell.

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..... [2]

(f) HCMV is known to infect some types of human cell that carry out the mitotic cell cycle.

Studies have shown that in the presence of one tegument protein, UL69, the cell cycle stops in the G1 stage.

Outline the effects the presence of UL69 will have on the normal activity of the mitotic cell cycle.

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.....

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..... [3]

(g) After a person has been infected with HCMV, the virus remains in a dormant state in the body for life.

If the virus becomes active again (reactivates), the virus will only cause serious illness if the person has a weak immune system at that time.

Explain why the response to reactivation of HCMV is more likely to cause serious illness in a person who has a weak immune system.

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..... [4]

[Total: 15]

Question No 33 - (9700_w22_22_3)

Subsection Topics: (a) : 10.1 - Infectious diseases | (b) : 10.2 - Antibiotics | (c) : 6.1 - Structure of nucleic acids and replication of DNA

Plasmodium falciparum is one species of *Plasmodium* that causes the life-threatening disease malaria. With early diagnosis and the correct drug treatment, the pathogen can be eliminated from the body, particularly if the disease is not severe.

(a) Name the type of pathogen that causes malaria.

..... [1]

(b) To help prevent the development and spread of drug resistance in *Plasmodium*, the World Health Organization (WHO) recommends using a treatment known as artemisinin-based combination therapy (ACT).

ACT involves two different types of drug:

- a fast-acting drug derived from a compound known as artemisinin, which causes a rapid decrease in the number of *P. falciparum*
- one or more longer-acting, non-artemisinin, drugs that eliminate any remaining pathogens.

(i) Suggest why using ACT with the two different types of drug is more effective in preventing the development of drug resistance in *Plasmodium* than a treatment using only one type of drug.

.....

.....

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.....

..... [2]

(ii) In some areas, partial artemisinin resistance has developed. This means ACT takes a longer time for the pathogen to be eliminated from the body.

Explain why there is an increased risk of transmission of the pathogen to other people if a person is receiving ACT and the pathogen has partial artemisinin resistance.

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..... [2]

-

(c) ACT can act on the stage of the life cycle of *P. falciparum* that occurs within red blood cells. The cells of *P. falciparum* in this stage are known as trophozoites.

Fig. 3.1 is a photomicrograph of a blood smear (thin layer of cells). Some of the red blood cells contain trophozoites.

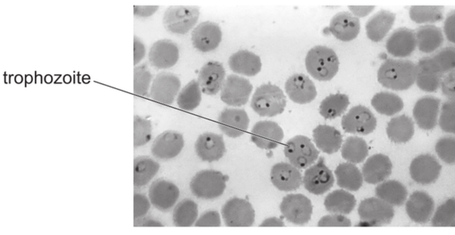

Fig. 3.1

PfK13 is a protein that has an important role in the development of the trophozoite stage of *P. falciparum*. The gene *kelch13* codes for PfK13.

Two different mutations of *kelch13*, known as F446I and C580Y, were investigated to see if they were associated with partial artemisinin resistance. Details of these mutations are summarised in Table 3.1.

Table 3.1

name of mutation	change in DNA		change in protein PfK13	
	nucleotide present in *kelch13*	nucleotide present after mutation	amino acid before mutation	amino acid after mutation
F446I	thymine (T)	adenine (A)	phenylalanine (phe)	isoleucine (ile)
C580Y	guanine (G)	adenine (A)	cysteine (cys)	tyrosine (tyr)

(i) Using gene *kelch13* and mutation F446I as examples, explain the difference between a gene and a gene mutation.

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..... [3]

(ii) In the investigation, the survival rate of trophozoites within red blood cells was determined for two different concentrations of an artemisinin-based drug known as DHA.

Two different strains, **A** and **B**, of *P. falciparum* were tested. Three different cultures of each strain were involved:

- no mutation in *kelch13* (control)
- *kelch13* F446I mutation
- *kelch13* C580Y mutation.

Table 3.2 shows the six different cultures tested and the trophozoite survival rate for each culture.

Table 3.2

culture number	culture details	mean percentage survival rate of trophozoite	
		DHA concentration 20 nmol dm^{-3}	DHA concentration 700 nmol dm^{-3}
1	strain **A** no mutation	3.15	0.00
2	strain **A**, F446I mutation	26.00	0.73
3	strain **A**, C580Y mutation	33.08	0.91
4	strain **B** no mutation	2.86	0.00
5	strain **B**, F446I mutation	13.50	0.53
6	strain **B**, C580Y mutation	17.50	0.63

State the main conclusions that can be drawn from the results shown in Table 3.2.

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..... [3]

[Total: 11]

Question No 34 - (9700_w22_23_5)

Subsection Topics: (a) : 3.1 - Mode of action of enzymes | (b) : 6.1 - Structure of nucleic acids and replication of DNA | (c) : 6.1 - Structure of nucleic acids and replication of DNA | (d) : 6.1 - Structure of nucleic acids and replication of DNA

Cathelicidin LL-37 is a cell signalling compound that stimulates many different cells in humans. One role of cathelicidin LL-37 is stimulating the production of endothelial cells in the formation of capillaries during wound healing.

(a) (i) Explain how it is possible for many different cell types to respond to the same cell signalling compound.

.....

.....

.....

.....

..... [2]

(ii) Describe the appearance of the endothelial cells of a capillary.

.....

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..... [2]

Cathelicidin LL-37 is a protein composed of 37 amino acids.

Table 5.1 shows:

- the sequence of the first 10 amino acids in the primary structure of cathelicidin LL-37
- DNA triplets in the non-transcribed strand in the gene that codes for the first 10 amino acids in the primary structure of cathelicidin LL-37.

Table 5.1

amino acid position	1	2	3	4	5	6	7	8	9	10
amino acid	leu	leu	gly	asp	phe	phe	arg	lys	ser	lys
DNA triplet	CTG	CTG	GGT	GAT	TTC	TTC	CGG	AAA	TCT	AAA

Table 5.2 shows the triplets of bases in **DNA** and the amino acids for which they code.

Table 5.2

first base	second base: T		C		A		G		third base
T	TTT	phe	TCT	ser	TAT	tyr	TGT	cys	**T**
	TTC		TCC		TAC		TGC		**C**
	TTA	leu	TCA		TAA	stop	TGA	stop	**A**
	TTG		TCG		TAG		TGG	try	**G**
C	CTT	leu	CCT	pro	CAT	his	CGT	arg	**T**
	CTC		CCC		CAC		CGC		**C**
	CTA		CCA		CAA	gln	CGA		**A**
	CTG		CCG		CAG		CGG		**G**
A	ATT	ile	ACT	thr	AAT	asp	AGT	ser	**T**
	ATC		ACC		AAC		AGC		**C**
	ATA	ile	ACA		AAA	lys	AGA	arg	**A**
	ATG	met	ACG		AAG		AGG		**G**
G	GTT	val	GCT	ala	GAT	asp	GGT	gly	**T**
	GTC		GCC		GAC		GGC		**C**
	GTA		GCA		GAA	glu	GGA		**A**
	GTG		GCG		GAG		GGG		**G**

(b) Mutations of DNA base sequences in a gene can affect the primary structure of proteins.

Use the information in Table 5.1 and Table 5.2 to suggest the effect on the primary structure of cathelicidin LL-37 of:

(i) the substitution of the base T with the base A in the middle of the triplet at position 5

..... [1]

(ii) the deletion of base T in the triplet at position 2

.....

.....

..... [2]

(iii) the insertion of base G between bases G and T in the triplet at position 3.

.....

.....

..... [2]

(c) The genetic code is described as universal.

Explain why the genetic code is described as universal.

.....

.....

..... [1]

(d) Use Table 5.2 to explain why some mutations have no effect on the primary structure of a protein.

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.....

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..... [2]

[Total: 12]

Question No 35 - (9700_m21_22_2)

Subsection Topics: (a) : 6.1 - Structure of nucleic acids and replication of DNA | (b) : 2.2 - Carbohydrates and lipids | (c) : 3.1 - Mode of action of enzymes | (d) : 3.2 - Factors that affect enzyme action

Starch molecules are the main storage molecules in many types of cereal grain, such as the grain of the barley plant.

(a) When the seed inside a barley grain germinates, genes coding for digestive enzymes are switched on. The enzymes that are synthesised catalyse the hydrolysis of storage molecules such as proteins and starch.

(i) Explain what is meant by a gene.

.....

.....

.....

.....

..... [2]

(ii) The hydrolysis of proteins in the barley seed produces amino acids that can be used in the synthesis of the proteins required for formation of the seedling (young plant).

Fig. 2.1 is an incomplete diagram of the molecular structure of the smallest amino acid, glycine. Each molecule of glycine has two carbon atoms.

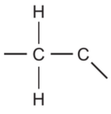


Fig. 2.1

Complete Fig. 2.1 to show the molecular structure of glycine. [2]

(iii) Starch is a mixture of two different molecules.

Name these **two** molecules.

.....

..... [1]

Two of the enzymes synthesised by the barley seed are α-amylase and maltase. These are involved in the hydrolysis of the stored starch during seedling formation.

In the food industry, the starch extracted from barley seeds (barley starch) is used in the production of sugar syrups. Fig. 2.2 summarises the reactions catalysed by α-amylase in the production of maltose syrup and by maltase in the production of glucose syrup.

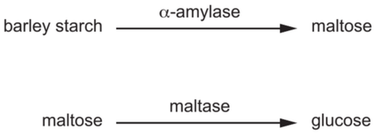


Fig. 2.2

(b) Some of the substances shown in Fig. 2.2 are listed in Table 2.1.

Complete Table 2.1 to identify which of the terms polysaccharide, monosaccharide and macromolecule apply to each of the substances listed.

Use a tick (✓) if the term applies and a cross (✗) if the term does not apply.

Put a tick (✓) or a cross (✗) in every box.

Table 2.1

substance	polysaccharide	monosaccharide	macromolecule
glucose			
maltase			
maltose			
starch			

[3]

When producing sugar syrups, there are advantages in using enzymes extracted from microorganisms.

For example, some enzymes extracted from microorganisms are heat stable. Heat-stable enzymes are used to increase productivity because the reactions can be carried out at higher temperatures.

(c) Suggest **one other** advantage of using enzymes obtained from microorganisms, rather than enzymes extracted from barley seeds, in the production of sugar syrups.

.....

..... [1]

(d) Fig. 2.3 is a graph showing how the activity of α-amylase extracted from barley seeds changes as the temperature increases from 10 °C to 66 °C.

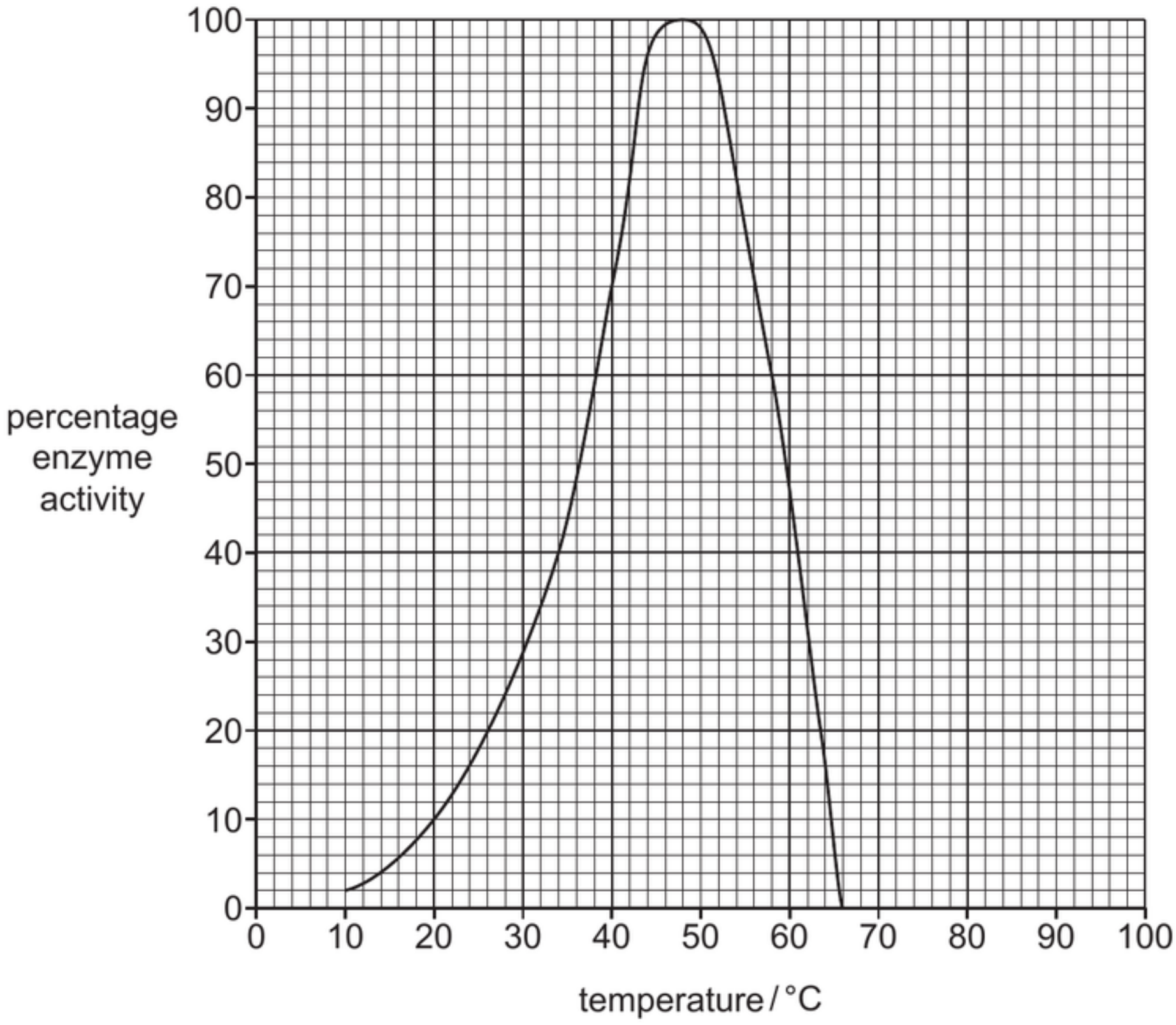


Fig. 2.3

(i) Explain the effect of temperature on the activity of α-amylase extracted from barley seeds, as shown in Fig. 2.3.

.....

.....

.....

.....

.....

.....

..... [3]

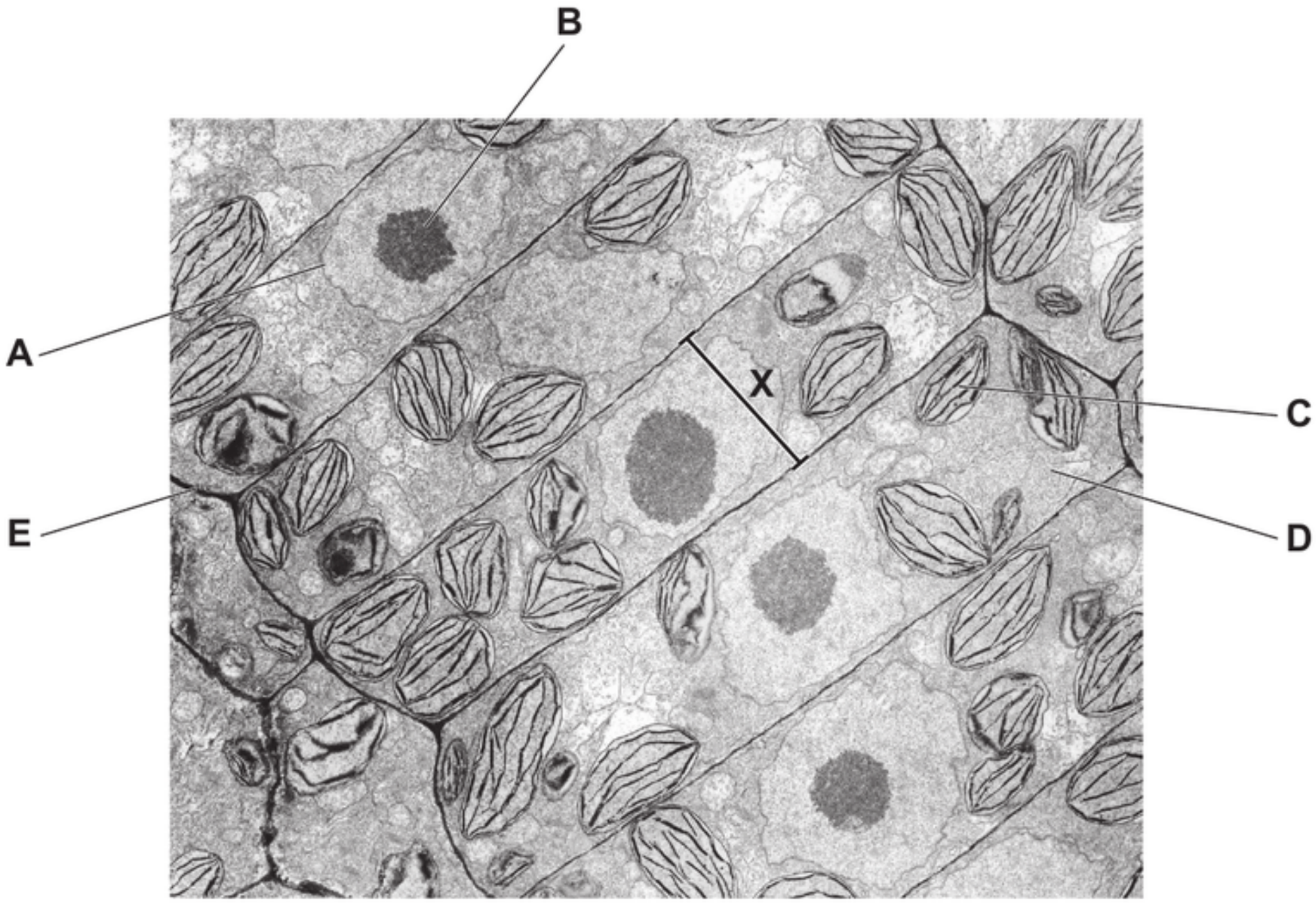
(ii) Sketch on Fig. 2.3 the curve that would be obtained using α-amylase enzyme that is heat stable. [2]

[Total: 14]

Question No 36 - (9700_s21_21_1)

Subsection Topics: (a) : 1.1 - The microscope in cell studies | (b) : 1.2 - Cells as the basic units of living organisms | (c) : 1.1 - The microscope in cell studies

Fig. 1.1 is a transmission electron micrograph of cells from duckweed, *Spirodela oligorrhiza*.



magnification ×4275

Fig. 1.1

(a) Calculate the actual width of the cell labelled **X**.

Write down the formula you will use to make your calculation.

Show your working and give your answer in micrometres to one decimal place.

formula

..... μm [3]

(b) (i) Table 1.1 lists some biological molecules found in plant cells.

Complete Table 1.1 by choosing **one** letter from Fig. 1.1 that indicates a cell structure where each biological molecule is found.

Table 1.1

biological molecule	letter from Fig. 1.1
DNA	
cellulose	
phospholipid	
histone proteins	

[4]

(ii) State the name of a cell structure, **visible in Fig. 1.1**, where ATP is synthesised.

..... [1]

(iii) Name a cell structure that produces mRNA.

..... [1]

(c) Describe the evidence from Fig. 1.1 that shows that the image is a transmission electron micrograph.

.....

.....

.....

.....

.....

.....

..... [2]

[Total: 11]

Question No 37 - (9700_s21_22_1)

Subsection Topics: (a) : 5.2 - Chromosome behaviour in mitosis | (b) : 6.1 - Structure of nucleic acids and replication of DNA

(a) Fig. 1.1 is a photomicrograph of a region of eukaryotic tissue. Some of the cells are in stages of mitosis.

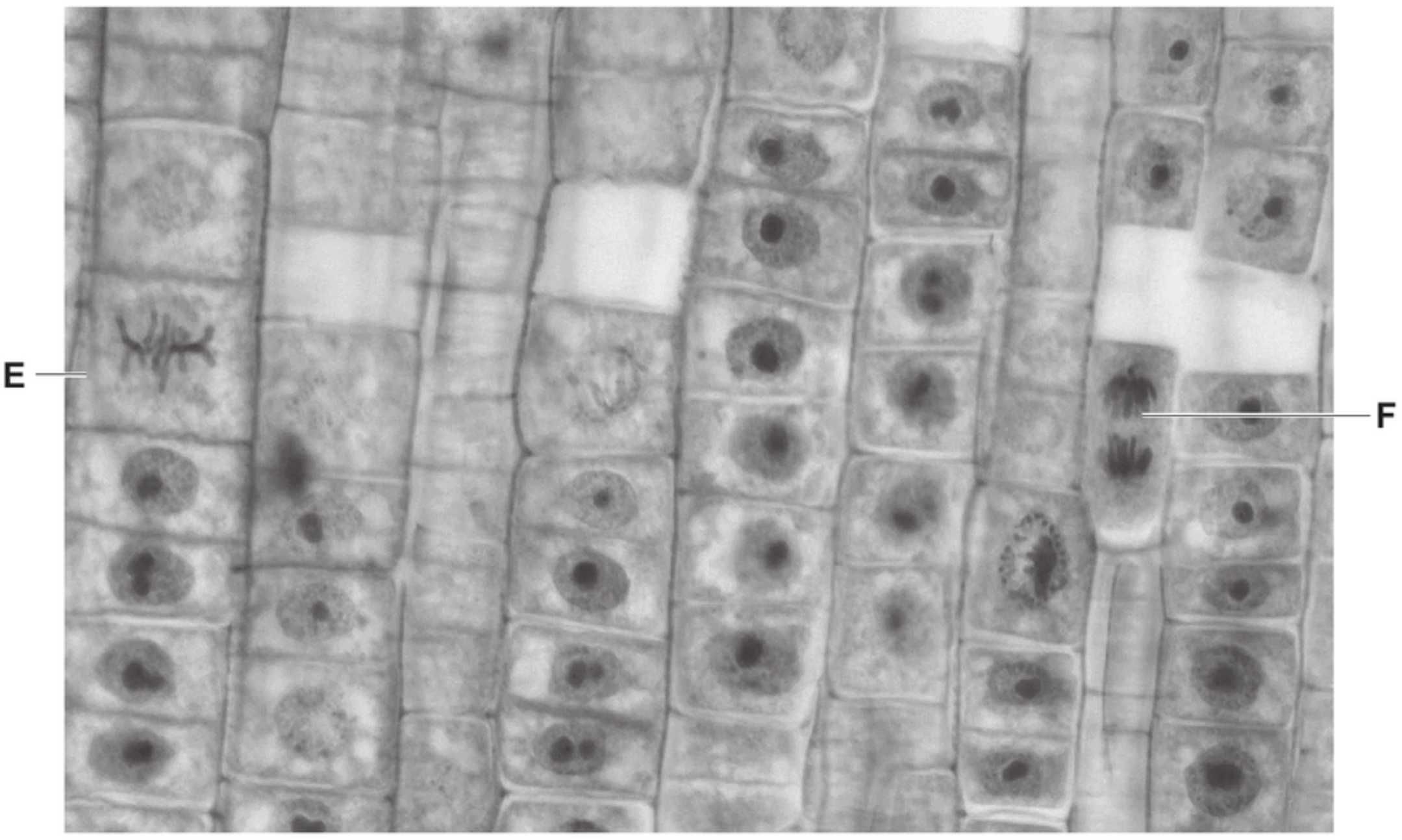


Fig. 1.1

(i) Identify which stage of mitosis is shown in cell **E** and in cell **F** in Fig. 1.1.

E .....

F ..... [2]

(ii) Microtubules are present within the cells that are in stages of mitosis, but these are not visible in Fig. 1.1.

State the function of microtubules in mitosis.

.....

.....

..... [1]

(iii) State, with a reason, whether Fig. 1.1 shows a region of animal or plant tissue.

.....

..... [1]

(b) Semi-conservative replication of DNA occurs during interphase, before mitosis begins.

Write the correct term in the spaces provided to complete each of statements **A** to **D**.

A The DNA double helix unwinds and is separated into two template strands when

..... bonds holding the two strands together are broken.

B One of the template strands of DNA is copied in fragments. The enzyme ..... is required to join the fragments together to form a continuous strand of DNA.

C Complementary DNA nucleotides are added to the template strands, catalysed by the enzyme ..... .

D ..... are regions of repeating nucleotide sequences at the ends of chromosomes that allow the continued replication of DNA, without the loss of genes.

[4]

[Total: 8]

Question No 38 - (9700_s21_22_3)

Subsection Topics: (a) : 8.1 - The circulatory system | (b) : 4.2 - Movement into and out of cells | (c) : 11.1 - The immune system | (d) : 1.2 - Cells as the basic units of living organisms | (e) : 2.3 - Proteins

In mammals, some cell signalling molecules are steroid (lipid) hormones. These hormones are transported in the bloodstream to reach capillary networks.

At a capillary network, hormones pass out of the blood into tissue fluid.

(a) Fig. 3.1 is a diagram of a capillary network.

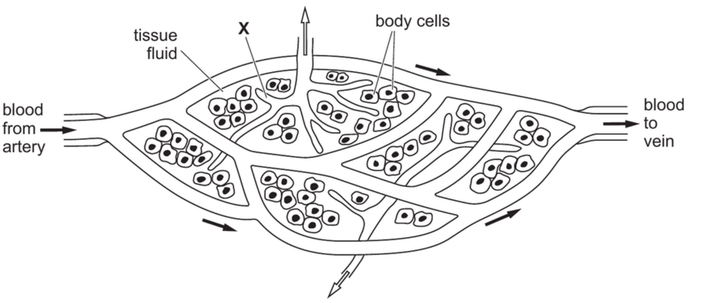


Fig. 3.1

(i) Describe the **differences** between the blood arriving at the arterial end of the capillary network and the tissue fluid surrounding the body cells.

.....

.....

.....

.....

.....

.....

..... [3]

(ii) Not all the tissue fluid passes back into the blood capillaries to enter the bloodstream. Some of the tissue fluid drains into blind-ended vessels, such as vessel **X** shown in Fig. 3.1.

Name the fluid that is formed in vessel **X**.

..... [1]

Hormone **S** is a steroid hormone involved in cell signalling.

Fig. 3.2 shows the sequence of events that occurs when hormone **S** enters a target cell.

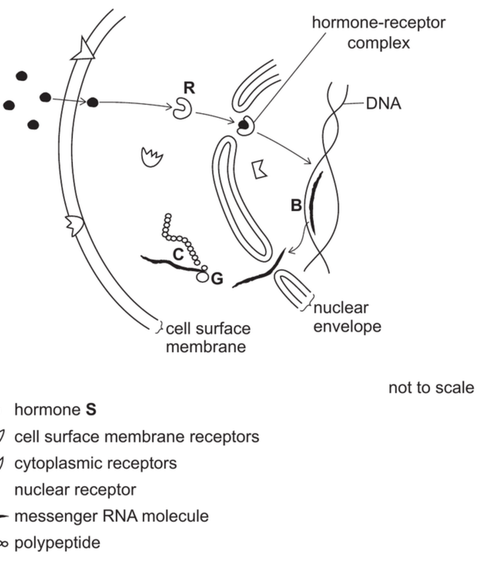


Fig. 3.2

(b) Explain why hormone **S**, shown in Fig. 3.2, does not need to pass through a transport protein to enter the cytoplasm of the target cell.

.....

.....

.....

.....

..... [2]

(c) The target cell can respond to other cell signalling molecules in addition to hormone **S**. The cell has receptors in the cell surface membrane, in the cytoplasm and in the nucleus.

Explain why hormone **S** binds only with receptor **R** in the cytoplasm and **not** with the other receptors shown in Fig. 3.2.

.....

.....

(d) The hormone-receptor complex shown in Fig. 3.2 enters the nucleus and binds to DNA. This

switches on a gene coding for a polypeptide that is synthesised in the cytoplasm.

(i) Name the structure through which the hormone-receptor complex enters the nucleus.

..... [1]

(ii) Name the processes occurring at **B** and **C**.

B .....

C ..... [2]

(iii) Name structure **G**.

..... [1]

(e) Cell signalling by hormone **S** results in the production of a functioning globular protein molecule composed of three identical polypeptide chains.

After the synthesis of these polypeptides, changes need to occur to form the functioning globular protein molecule.

Outline the changes that need to occur to form the functioning globular protein molecule.

.....

.....

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.....

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..... [4]

[Total: 15]

Answer for Question 1 (9700_m25_22_5)

Question	Answer	Marks
5(a)	histones ; chloroplasts ; bacteria / cyanobacteria / Archaea ; **accept** named prokaryote cytoplasm ;	**4**
5(b)(i)	non-transcribed strand ;	**1**
5(b)(iii)	<table><tr><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th></tr><tr><td>A</td><td>U</td><td>G</td><td>C</td><td>A</td><td>U</td></tr></table> ;	**1**

Question	Answer	Marks
5(c)	*any **three** from* 1 ref. to non-competitive inhibition ; 2 binding of alpha-amanitin changes shape of active site ; 3 active site, no longer / less, complementary to, substrate / DNA **or** fewer enzyme–substrate complexes formed ; 4 prevents RNA polymerase from, binding to DNA / unwinding DNA / rewinding DNA ; 5 blocks movement of the polypeptides of the enzyme / prevents the enzyme changing shape / hinders induced fit ; 6 RNA polymerase movement along DNA, prevented / slowed down ; **accept** prevents addition of nucleotides to the chain	**3**

Answer for Question 2 (9700_m24_22_6)

Question	Answer	Marks
6(a)	capsid ; **A** capsomere or protein coat **R** protein / glycoprotein / caspid	**1**
6(b)	*accept accounts based on primary and / or secondary immune response .* fewer cytokines released ; *and any **two** from:* fewer plasma cells, so fewer antibodies produced ; **A** B lymphocytes fewer macrophages stimulated / less production of 'angry' macrophages / AW / less antigen presentation by macrophages ; fewer T-killer cells stimulated to divide / less T-killer cells / less infected cells killed (by T-killer cells) ; fewer memory cells (produced by the primary response) ; AVP ;	**3**
6(c)	virus cannot enter the T-helper cell / CCR5 unable to trigger endocytosis of viral particle ;	**1**
6(d)	*any **three** from:* 1 (named) small mammal, injected / AW, with CCR5 ; **A** antigen 2 immune response occurs (over several weeks) ; **A** immune response described 3 plasma cells / B-lymphocytes / B-cells / splenocytes, extracted from spleen ; 4 plasma cells / B-lymphocytes / B-cells, fused with, myeloma / tumour / cancer / AW, cells (to form hybridomas) ; 5 screening / selection / AW, for hybridomas producing desired, (monoclonal) antibodies ; 6 AVP ; e.g. hybridoma cells separated (into wells) to produce clones ref. to large scale production	**3**

Answer for Question 3 (9700_m24_22_4)

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>4(a)(i)</td><td>all correct ;
<table>
<tr><td>position of nucleotide</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td></tr>
<tr><td>DNA template strand</td><td>C</td><td>A</td><td>C</td><td>T</td><td>A</td><td>C</td><td>T</td><td>C</td><td>C</td><td>A</td><td>A</td><td>C</td></tr>
<tr><td>primary transcript</td><td>G</td><td>U</td><td>G</td><td>A</td><td>U</td><td>G</td><td>A</td><td>G</td><td>G</td><td>U</td><td>U</td><td>G</td></tr>
</table></td><td>1</td></tr>
</table>

Answer for Question 3 (9700_m24_22_4)

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>4(a)(ii)</td><td>all 4 correct ;
<table>
<tr><td></td><td>aa1</td><td>aa2</td><td>aa3</td><td>aa4</td></tr>
<tr><td>amino acid</td><td>val
/ valine</td><td>met
/ methionine</td><td>arg
/ arginine</td><td>leu
/ leucine</td></tr>
</table></td><td>1</td></tr>
<tr><td>4(a)(iii)</td><td>any two from:
no effect on the protein structure ;
(because) all 4 triplets beginning with CA code for valine / CAA, CAG, CAT, CAC all code for valine ;
idea of the genetic code is, redundant / degenerate ;</td><td>2</td></tr>
<tr><td>4(a)(iv)</td><td>any three from:
first amino acid, unchanged / still val ;
changes the reading frame / described ; A.all codons (from mutation on) will change / frameshift mutation
deletion alters, all amino acids after the mutation / amino acid sequence / primary structure ;
ref. to, stop codon, causing premature chain termination / leading to shorter polypeptide ;
(leading to) changes, in the tertiary structure / active site / AW ;</td><td>3</td></tr>
<tr><td>4(b)</td><td>interphase <u>and</u> S phase circled ;</td><td>1</td></tr>
</table>

Answer for Question 3 (9700_m24_22_4)

Question	Answer	Marks
4(c)	*any **four** from:* *max three if points about transcription also given* 1 double helix unwinds, qualified ; e.g. using, enzyme / helicase breaking hydrogen bonds between strands 2 both strands act as templates ; 3 ref, activated (free DNA) nucleotides ; 4 DNA polymerase, plus example of role ; e.g. adds complementary nucleotides to exposed strand forms phosphodiester bonds (between adjacent nucleotides) proofreading / checking for errors / checking for mismatches 5 leading strand synthesised continuously / AW ; 6 lagging strand synthesised in (Okazaki) fragments ; 7 ligase connects (lagging strand), fragments / nucleotides, (with phosphodiester bonds) ; 8 semi-conservative replication / AW ; e.g. both new double helices have one, parental / conserved, strand and one newly synthesised strand	**4**
4(d)	ribose ; **I** pentose	**1**

Answer for Question 4 (9700_s24_21_3)

3(a)	(insect) vector / *Anopheles* / (a) mosquito ; *Plasmodium, falciparum / ovale / malariae / vivax* ; **A** *knowlesi* *Vibrio cholerae* **and** cholera ; **A** other pathogens and associated diseases that are transmitted in the same way *Mycobacterium*, *tuberculosis / bovis* ; airborne droplets / droplet infection / aerosol (infection) ; **I** air droplets **I** water droplets from, coughing / sneezing **A** alternative transmission only if *Mycobacterium bovis* stated e.g. (eating) contaminated meat (from infected cattle) (drinking) contaminated milk (drinking) unpasteurised milk from contaminated, cows / cattle	**5**

Question	Answer	Marks
3(b)	*any **two** from:* tenofovir competes with, (activated / phosphorylated) adenine nucleotide / deoxyribose adenosine triphosphate / dATP, for active site / to prevent nucleotides being added to elongating chain ; **A** (tenofovir acts as a) competitive inhibitor (of reverse transcriptase) tenofovir forms a phosphodiester bond to elongating DNA strand, but stops further reactions / AW ; tenofovir has, no 3´ -OH so next nucleotide cannot form a phosphodiester bond / no (deoxy)ribose so cannot form phosphodiester bond ; **A** pentose **R** sugar unqualified	**2**
3(c)(i)	20 (%) ; **R** answers with decimal places	**1**

Answer for Question 4 (9700_s24_21_3)

Question	Answer	Marks
3(c)(ii)	*there must be at least one statement or at least one explanation to gain max 4, otherwise mark to max 3* *any **four** from:* **1** supply, condoms / femidoms / dental dams / item(s) for protection during sex ; **2** barrier to transmission during sexual intercourse ; **3** *ref. to*, needle exchange schemes / other suitable support for intravenous drug (ab)users ; **I** clean needles **4** decreases risk of sharing contaminated equipment / AW ; **5** use, new needles / new syringes / sterilised equipment / AW, for medical procedures ; **I** clean needles **6** decreases risk of transmission from contaminated blood ; **7** provide testing for HIV, in high risk groups / to individuals at high risk ; **8** for early diagnosis so newly infected people so can start drug treatment immediately ; **8** test pregnant women for HIV / provide powdered milk to women who are HIV positive ; **9** prevent women who are HIV positive passing HIV in breast milk ; **10** prevent people who are HIV positive being blood donors / screen donated blood / heat-treat donated blood ; **11** prevent people receiving blood infected with HIV, during blood transfusions / operations ; **12** carry out contact tracing ; **13** locate people who, are undiagnosed / may be HIV positive / should be offered test ; **14** supply (named) drug(s) to people, living with HIV / who are HIV positive / pregnant women with HIV ; **15** prevents HIV, spreading throughout the body / infecting more T-lymphocytes ; **A** to reduce viral load **16** provide, education / information, about, HIV treatments / HIV transmission ; **17** to raise awareness of ways to reduce infection / AW ; **A** use of barrier methods during sex / safer sex **18** AVP ; e.g. law to make it illegal to knowingly transmit the virus	**4**

Answer for Question 5 (9700_s24_22_4)

Question	Answer	Marks
4(a)	*allow points from correctly labelled diagram* (monomers of) beta-glucose / β-glucose ; **R** α-glucose / two β-glucoses *plus any **two** from:* *max 1 if no monomer stated* (joined by) 1, 4 glycosidic bonds ; **A** 1,4 glucosidic bonds **R** 1,4 and 1,6 bonds each (β–) glucose rotated by 180° compared to adjacent (β–)glucose ; AW linear / straight, chain / molecule; unbranched ;	**3**
4(b)(i)	*any **one** from:* increases rate of translation of, enzyme / nitrate reductase ; increases, enzyme / nitrate reductase, synthesis / concentration ; **A** more nitrate reductase produced *idea of* more metabolically efficient ; e.g. enzyme only produced when needed AVP ; e.g. more nitrate is reduced to nitrite / more nitrite is formed leads to increased supply of nitrite for amino acids / amino acid synthesis	**1**

Answer for Question 5 (9700_s24_22_4)

Question	Answer	Marks
4(b)(ii)	*any* ***two*** *from:* improves accuracy of results / results not by eye / results not subjective ; **A** detects smallest change in, (intensity of) colour / concentration / quantity provides quantitative results / obtain numerical values ; **A** described e.g. absorbance values / can measure absorbance/ gives percentage transmission / absorbance readings *idea that* different, intensities / shades of, colour / magenta / red-purple, relate to different, quantities / concentrations, of nitrites ; **A** relate to (rates of) nitrate uptake can produce calibration curve (for quantitative results) ; AVP ; e.g. can detect, (very) low concentrations / faintly coloured samples	**2**

Answer for Question 5 (9700_s24_22_4)

Question	Answer	Marks
4(c)(i)	*accept hydrogen ions / H^+, for protons* *max 3 if no ref. to amino acids* *any **four** from:* **1** protons, moved by active transport / pumped, out of (companion) cell ; **A** using, energy / ATP *for active transport* **2** protons, moved into / enter / AW, cell wall / apoplast ; **R** if moved out to phloem sieve tube **3** proton gradient builds up in, apoplast / cell wall ; **A** higher concentration **A** high concentration if mp4 gained **4** protons move back (into companion cell), by facilitated diffusion / AW ; e.g. down, electrochemical / concentration, gradient from high(er) to low(er) concentration **A** diffuse *if movement is described through a transport protein in mp5* **5** protons cotransport amino acids **or** amino acids move with protons through, a cotransporter / a cotransport protein / (amino acid) transporter ; **6** amino acids, transported / AW, against their concentration gradient ;	**4**
4(c)(ii)	plasmodesmata present ; **A** movement is down the, concentration / diffusion, gradient **A** because there is a high(er) concentration in the companion cell **ora** for phloem sieve tube (sap)	**1**

Answer for Question 5 (9700_s24_22_4)

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>4(d)</td><td>0.2 mmol dm^{-3} constant rate v 5.0 mmol dm^{-3}, rate not constant / described ;

0.2 mmol dm^{-3} lower rate than 5.0 mmol dm^{-3} ; ora 5.0 mmol dm^{-3} higher rate
A faster / slower, rate for higher / lower, rate
A (overall) steeper rate / less steep rate

calculated rates to support ;</td><td>2</td></tr>
<tr><td>4(e)</td><td>any four from:

1 (experiments suggest mainly) active transport / active uptake ;
A uptake, is an active process / needs energy / needs ATP
if mp8 given, allow ‘active transport and facilitated diffusion’

2 comparison of experiments with control, any one ;
<table>
<tr><th>expt</th><th>discussion point</th></tr>
<tr><td>1</td><td>oxygen required for (complete) uptake A aeration required
or
almost no /AW, uptake, with no oxygen / in anaerobic conditions</td></tr>
<tr><td>2</td><td>almost no / AW, uptake, in, low temperature / at 3°C
or
uptake, higher / AW, at 30°C / in control</td></tr>
<tr><td>3</td><td>proteins / enzymes, are, required for / involved in, uptake
or
(much) lower / AW, uptake when, proteins not synthesised / protein synthesis inhibitor present</td></tr>
<tr><td>4</td><td>slightly lower / very similar, uptake / AW, without any bacteria
or
slightly higher / very similar, uptake / AW, with bacteria (control)</td></tr>
</table>
3 one comparative result / manipulated data, with units, to support mp2 ;</td><td>4</td></tr>
</table>

Answer for Question 5 (9700_s24_22_4)

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>4(e)</td><td>
<table>
<tr><th>experiment</th><th>experiment v control</th><th>or</th><th>lower by</th><td rowspan="5">only needs to state control value once somewhere in response</td></tr>
<tr><td>1</td><td>0.4 v 10.9 μmol g^{−1}</td><td rowspan="4"></td><td>10.5 μmol g^{−1}</td></tr>
<tr><td>2</td><td>0.6 v 10.9 μmol g^{−1}</td><td>10.3 μmol g^{−1}</td></tr>
<tr><td>3</td><td>1.4 v 10.9 μmol g^{−1}</td><td>9.5 μmol g^{−1}</td></tr>
<tr><td>4</td><td>10.0 v 10.9 μmol g^{−1}</td><td>0.9 μmol g^{−1}</td></tr>
</table>
discussion points
4 aerobic respiration needs oxygen ;

5 lower temperature means lower activity of enzymes involved in respiration ;

6 ref. to ATP (for active transport) ;
e.g. (aerobic) respiration produces ATP
less respiration means less ATP produced
no ATP for, conformational change / AW (of carrier protein)

7 some (facilitated) diffusion because some uptake without oxygen ;

8 protein synthesis needed for transport proteins ;
A membrane / transport / carrier / channel, proteins not being synthesised
A no protein synthesis so less ATP synthase

9 effect of lower temperature on transport ; ora for control
e.g. reduces rate of (facilitated) diffusion
affects, ATPase / carrier protein, for active transport
transport proteins less efficient at low temperature

10 bacteria will have, little / no, effect on uptake
or
(normally) bacteria (associated with roots), increase / help, nitrate uptake ;

11 AVP ; e.g. idea that nitrate uptake involves metabolic processes
</td><td></td></tr>
</table>

Answer for Question 6 (9700_s24_22_1)

Question	Answer	Marks
1(a)	*any **two** from:* **1** (by) contracts / contracting / contraction, and, relaxes / relaxing / relaxation ; *must be in context of bronchioles* **R** if includes *ref. to* stretch / expand / recoil **R** if in context of *bronchus or trachea (then ecf in subsequent mps)* **2** diameter / lumen size, can be, controlled / changed ; AW **A** contraction, decreases diameter (of lumen) / constricts **A** relaxation (after contraction) increases diameter (of lumen) / widens / dilates / expands **R** vasoconstriction / vasodilation **3** *idea of,* controls / regulates, flow of air / volume of air flowing ; AW **I** statements such as 'lets air in' / 'allows inhalation and exhalation' **A** oxygen in / carbon dioxide out, *instead of air flow* **R** oxygen out and carbon dioxide **4** AVP ; e.g. contract to, reduce air movement / prevent entry of contaminants *idea of* normally relaxed but can, contract / cause constriction, when needed *max 1 if response relates function to inhalation and exhalation* *0 marks if incorrectly stated as <u>elastic tissue or elastic fibres</u>*	**2**
1(b)(i)	stage micrometer / stage micrometer scale ;	**1**

Answer for Question 6 (9700_s24_22_1)

Question	Answer	Marks
1(b)(ii)	yes, qualified ; e.g. 0.2 mm = 200 µm 0.2 mm / smallest student can see, is less than 0.25 mm 250 µm = 0.25 mm 250 µm / cell length, is longer than 200 µm the cell is 50 µm longer (than 0.2 mm) the cell is 0.05 mm longer (than 0.2 mm) *allow if converted to standard form* (2×10^{-4} v 2.5×10^{-4} m) *must have units* *must include numerical values*	1
1(c)(i)	*any **two** from:* wall, of one layer / is one cell thick ; **I** capillary is one cell thick **A** thin wall / endothelial cells are a single layer **A** endothelium is, a single layer (of cells) / one cell thick *idea that* red blood cells transported in single file ; *idea that* red blood cells diameter (approximately), as large / same, as capillary (lumen) ; **A** if diameter (e.g. 7µm) stated as being similar to capillary size *idea of* diameter of capillary narrower than smooth muscle cell ; AVP ; e.g. no muscle and elastic layer muscle fibres / elastic fibres / collagen, not present *ref. to* different shapes of red blood cell / red blood cell showing flexibility, to pass through (narrow) capillary	2

Answer for Question 6 (9700_s24_22_1)

Question	Answer	Marks
1(c)(ii)	*allow tissue fluid / fluid surrounding cells, instead of (smooth muscle) cells* *allow, blood / plasma, for capillary* *allow O_2 for oxygen and CO_2 for carbon dioxide* *any **three** from:* *capillary function* **1** named, substance / type of substance, that is supplied to smooth muscle cells or is a product removed from the cells ; e.g. (supply) oxygen / nutrients / glucose / amino acids / cell-signalling molecule e.g. (removes) carbon dioxide / lactic acid / waste **A** exchange of respiratory gases (between capillary and cells) **I** plasma proteins into tissue fluid *structure to function* **2** thin wall / AW, so short distance ; **R** capillary is thin **3** endothelial pores / fenestrations, for more efficient passage / AW ; **A** gaps, between / within, (endothelial) cells (of capillary wall) **A** increases, quantity / rate of supply (of substances) **A** endothelial pores for formation of tissue fluid (around cells) **R** if blood leaves to make tissue fluid **4** (endothelial) pores / AW, for passage of, phagocytes / monocytes / macrophages / neutrophils ; **5** small (size) / narrow diameter, to reach cells / so (all) cells are close ; **A** value in range 5–10 μm **A** small size / narrow lumen, slows (rate of) blood flow **6** detail about red blood cell and, respiratory gases / gas exchange / oxygen / carbon dioxide ; e.g. narrow lumen slows red blood cell movement for uptake of oxygen slows red blood cell movement to increase time for exchange of gases only one red blood cell fits (at a time) so short diffusion distance red blood cells are close to (muscle) cells for gas exchange red blood cells squeeze through, (so) distance for oxygen to reach cells is minimised	**3**

Answer for Question 6 (9700_s24_22_1)

Question	Answer	Marks
1(d)(i)	(a gene mutation is a) change in the sequence of base pairs in a DNA molecule ; **A** change in the DNA, base / nucleotide, sequence **I** change in RNA base sequence **I** names of mutations codes for / may result in / results in / AW, an altered / a different / a changed, polypeptide ; **A** protein / amino acid sequence / primary structure, *for polypeptide*	**2**
1(d)(ii)	*any **two** from:* differences owing to, RNA / gene, splicing ; **A** primary transcript for RNA **A** *ref. to* alternative splicing **R** DNA splicing **R** mutation occurring during gene splicing (differences occur during) removal of, introns / non-coding sequences ; **R** if introns described as bases / nucleotides / codons **R** different number of introns removed / some introns remain exons / coding sequences, detail ; e.g. joined differently / in a different combination in middle (of transcript), removed / not included for repeating sequence, removed / not included (so) messenger RNA / mRNA, formed is different ;	**2**

Answer for Question 6 (9700_s24_22_1)

Question	Answer	Marks
1(d)(iii)	*allow ref. to binding sites as plural* **I** *ref. to* active site(s) *any* ***one*** *from:* (still have) similar, tertiary structure / binding site shape ; **A** similar 3D shape **R** same **A** *idea of* binding sites still complementary to attach to (the) proteins removed amino acids are not structural amino acids ; removed amino acids are not part of binding site ; **A** description R-group interactions (still) the, same / similar ; AVP ; e.g. idea of more than one binding site and only, one / a few, changed **A** same type of binding site, but a different number	**1**

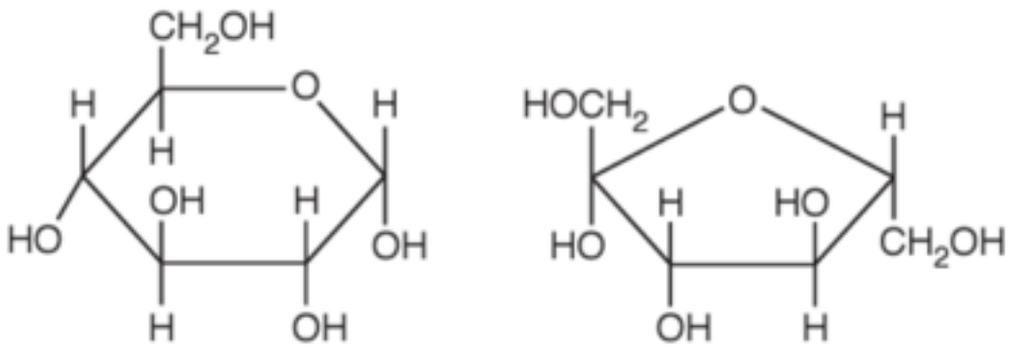
Answer for Question 7 (9700_s24_23_6)

<table>
<tr><td>6(a)</td><td>must have correct matching information about mRNA <u>and</u> DNA

any three correct (rows) from:

<table><tr><th>mRNA</th><th>DNA</th></tr><tr><td>one strand / single-stranded / one polynucleotide chain</td><td>two strands / double-stranded / two polynucleotide chains ;
A double helix</td></tr><tr><td>RNA, bases not paired / base pairing not present</td><td>DNA base pairing present ;</td></tr><tr><td>ribose (sugar)</td><td>deoxyribose (sugar) ;</td></tr><tr><td>uracil, (adenine, cytosine, guanine) (base(s) / nucleotide(s))</td><td>thymine, (adenine, cytosine guanine) (base(s) /nucleotide(s)) ;</td></tr><tr><td>shorter / fewer nucleotides</td><td>longer / more nucleotides ;</td></tr></table></td><td>3</td></tr>
<tr><td>6(b)(i)</td><td>P <u>and</u> B ;</td><td>1</td></tr>
<tr><td>6(b)(ii)</td><td>C <u>and</u> G ;
held together by three hydrogen bonds (same as the artificial base pairs) ;</td><td>2</td></tr>
</table>

Answer for Question 8 (9700_w24_21_4)

Question	Answer	Marks
4(a)(i)	glycosidic ;	1
4(a)(ii)	 *any **three** from:* label one monomer correctly ; α-glucose with a hydroxyl group on C1 ; fructose drawn with a hydroxyl group on C2 ; water used in the reaction ;	3
4(b)(i)	sieve plate ;	1

Answer for Question 8 (9700_w24_21_4)

Question	Answer	Marks
4(b)(ii)	*any* ***four*** *from:* **1** carbohydrate is transported in (phloem) sieve tubes ; **A** sucrose transported **A** sieve tube elements **2** as the percentage of outer stem tissue removed increases, the quantity of phloem (sieve tubes) remaining decreases ; **3** less, mass flow / translocation ; **4** 0 mg at 100% removal because all phloem removed / AW ; **5** carbohydrate is not transported in xylem tissue, as there is no transport when xylem tissue is left intact ; **6** *ref. to* movement to lower part of stem from source to sink ; **7** AVP ; e.g. *suggestion that* most of the (active) phloem is in the inner part of the outer stem *idea that* phloem sieve tubes are arranged in layers	**4**

Answer for Question 8 (9700_w24_21_4)

Question	Answer	Marks
4(c)	*any **four** from:* *max 3* **1** example of structural change to sucrase ; e.g. translation stops prematurely / truncated polypeptide / AW change in the primary structure / different amino acid(s) polypeptide does not, fold into / form, (correct) tertiary structure **2** suggestion of why sucrase is non-functional ; e.g. active site, not complementary / changed shape binding site changed shape, sucrose does not bind to active site catalytic site changed shape, glycosidic bond cannot be broken **3** polypeptide not produced as mRNA does not attach to ribosome ; **4** polypeptide recognised as abnormal and degraded ; *max 3* **5** deletion mutation is loss of one or more nucleotides (in the gene coding for sucrase) ; **6** (causes a) change in the sequence of, nucleotides / bases / base pairs, (in the, gene coding for sucrase / DNA molecule) ; **7** (causes a) change in the sequence of, nucleotides / bases, in, mRNA / an mRNA molecule ; **8** consequence to codons ; *(if not a deletion of, three / multiples of three)* all the codons after the deletion mutation are altered causes a frameshift *(deletion, of three / multiples of three)* one or more codons absent, then same sequence **9** mutation may, form a premature stop codon / introduce a stop codon ;	**4**

Answer for Question 9 (9700_w24_22_3)

Question	Answer	Marks
3(a)	*do not allow 'base' as AW for 'nucleotide'* *any* ***one*** *from:* *idea that* phosphodiester bond forms, between nucleotides on the same strand / between adjacent nucleotides / during polynucleotide formation / to form a sugar-phosphate backbone ; AW *look for understanding that more than one nucleotide needs to be present on the same strand* *idea that* phosphates, shown are only bound to one (pentose) sugars / each phosphate needs to be bound to two (pentose) sugars ;	**1**

Answer for Question 9 (9700_w24_22_3)

Question	Answer	Marks
3(b)	base / nucleotide, on left identified as guanine and, base / nucleotide, on right identified as cytosine ; **A** guanine and cytosine *as question has DNA-RNA* **I** cytosine and guanine *unless further qualified* dotted line as hydrogen bond / annotation related to dotted lines as hydrogen bonds / there are three hydrogen bonds between the bases; **A** H-bond *circle is* phosphate ; *pentagon / pentose, on left is* deoxyribose ; *also AVP if 'pentose'* double ring / base on left, identified as purine ; **A** guanine is a purine if mp1 gained single ring / base on right, identified as pyrimidine ; **A** cytosine is a pyrimidine if mp1 gained AVP ; e.g. label to any solid line bond as covalent bond phospho-ester bond, labelled / described pentose sugar, label to / described for, deoxyribose / ribose box drawn around one completed nucleotide and labelled 5' and 3' shown annotated ref. to antiparallel nature of base-pair	**4**

Answer for Question 10 (9700_w24_22_4)

Question	Answer	Marks
4(a)	replacing cells that are, damaged / destroyed / worn out / old ;	1
4(b)	*any **two** from:* result of mutation ; **A** example proto-oncogene to oncogene tumour suppressor gene inactive **I** mutation / mutated, *as a single term* short(er) / fast(er) / many / continuous, cell cycle(s) / cell divisions ; **A** shorter interphase **A** cells do not stop dividing **I** ref. to mitosis no contact inhibition / mitosis continues beyond space available / cell formation may spread to other nearby areas / AW ; ref. to normal (cell cycle) checkpoints not occurring ; **A** *idea that* substances needed for error checking not, available / functioning **A** errors not checked loss of (original / normal) function ; **A** example **A** non-functional (cell cycle continues because) fault in / errors in / no response to, cell signalling ; cells do not carry out apoptosis / no programmed cell death ; AVP ; e.g. different cell metabolism increase in telomerase (activity) telomeres do not shorten as quickly formation / presence, of blood vessels (feature of tumour) **A** angiogenesis lack of adhesion between cells ref. metastasis / described e.g. cells travel in, blood / lymph, to form tumours elsewhere in body **I** ref. to tumour spread in blood	2

Answer for Question 10 (9700_w24_22_4)

Question	Answer	Marks
4(c)	*any **two** from:* *idea that* after each, cell cycle / cell division / DNA replication, telomeres shorten ; (long telomeres means that DNA) replication can take place more times ; **A** allows continuous (DNA) replication *context is DNA and not cell replication* *idea that* ends of chromosomes are protected ; telomeres do not contain, genes / genetic information ; **A** telomeres are non-coding detail ; e.g. *idea that* after replication nucleotides at ends of DNA are lost lagging strand replication leads to unpaired nucleotides DNA polymerase cannot continue to end on lagging strand (replication) (long telomeres) allow, long life span / many divisions to occur / many mitoses ; AVP ; e.g. prevents chromosome ends from joining otherwise, mitosis could not occur / may lead to cell death	**2**
4(d)	*any **three** from:* differentiation has already started / AW ; **A** they are not undifferentiated **A** GMP cells are, differentiated / specialised (compared to stem cells) no self-renewal / AW ; **A** cannot produce a stem cell when they divide cannot form, all blood cell types / correct named ; (only) forms (immature) neutrophils and monocytes ;	**3**
4(e)	macrophage/s ; **I** mature monocytes / granulocyte / phagocyte	**1**

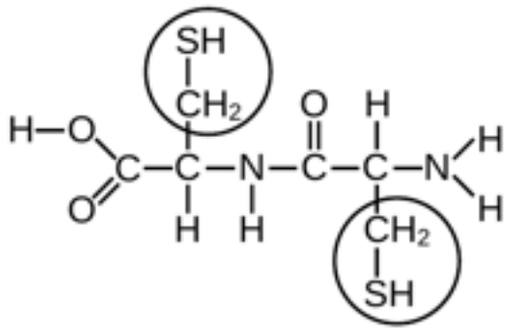
Answer for Question 10 (9700_w24_22_4)

Question	Answer	Marks
4(f)	antibody / immunoglobulin ;	1
4(g)	*mp2 and 3 need to see knowledge that self-antigens are on, self- / body / own, cells* *any **three** from:* **1** *idea that,* next stage / after thymus, is (T-lymphocyte) release into general circulation / blood ; **2** (if released) exposure to / activation by, (self-antigens on body) cells **or** (on exposure to self-antigens), immune response occurs against (body) cells ; **ora** only (T)lymphocytes that will respond only to, pathogens / foreign substances, are, left / released **3** (if released) harm to / destruction of / kills, (body) cells ; **4** need to prevent / otherwise, formation of memory T-cells ; **5** AVP ; e.g. need to prevent / (if released) may cause, autoimmune, disease / response (otherwise) T-helper will release cytokines to, enhance / AW, immune response against (body) cells (if cytokine released) may lead to, phagocytosis of / antibodies produced against, (body) cells (otherwise) T-killer cell will release substance to kill cells *also mp3* (faulty T-lymphocytes) cannot bind to, foreign / non-self, antigens	3

Answer for Question 11 (9700_w24_23_3)

Question	Answer	Marks
3(a)(i)	pyrimidine **;** *accept phonetic or close spellings, e.g.* pyramidine / pyrimadine / pirimadine / primidine	**1**
3(a)(ii)	*any **one** from:* each nucleic acid has 4 (types of) base **;** **A** has 4 bases DNA has A, T, C and G **and** RNA has A, U, C and G **;** **A** full names even if misspelt unless another molecule (e.g. thiamine) *idea that* in RNA U replaces T / DNA has T but RNA has U **;**	**1**
3(b)	*any **four** from:* *max 2 if answer is about transcription and mRNA* *penalise polypeptide once* **1** (triphosphate) activated / free, nucleotide (with thymine) **;** **2** thymine / T, pairs with, adenine / A **;** **I** complementary base pairing unqualified **3** adenine / A, on <u>template</u> strand **;** **4** formation of two hydrogen bonds between T and A **;** **I** H bonds between C and G **5** *ref to* DNA polymerase in correct context (e.g. correct base pairing / bond formation / proof reading) **;** **6** forms phosphodiester bond (between -OH of deoxyribose and phosphate of nucleotide) **;** **R** if DNA ligase **7** release of, pyrophosphate / P-P / two phosphates **;** **8** nucleotide added to the 3′ end of, newly-synthesised strand / leading strand / daughter strand (of DNA) **;** **A** extension is in the 5′ to 3′ direction	**4**
3(c)	**1** strands (are parallel and) run in <u>opposite</u> directions / one strand in 5′ to 3′ direction and other strand in 3′ to 5′ direction **;** *any **two** from:* **2** elongation / synthesis / extension / AW, of strand is, in 5′ to 3′ direction / not in 3′ to 5′ direction **;** **3** DNA polymerase, moves in the 5′ to 3′ direction / can only add nucleotides to the 3′ end **;** **4** *idea that* phosphate of each nucleotide is added to C3 of last nucleotide of growing strand **;** **5** leading strand is made continuously / lagging strand is made up of Okazaki fragments **;** **6** Okazaki fragments are attached together by DNA ligase **;**	**3**

Answer for Question 12 (9700_m23_22_2)

Question	Answer	Marks
2(a)	either **R** group circled **;** 	**1**
2(b)(i)	disulfide (bonds) **;**	**1**
2(b)(ii)	<u>exocytosis</u> **;** *plus any **two** from:* **either:** (idea of) vesicles will be large enough to contain many mucins ***/*** ref. to bulk transport **;** vesicles forming from Golgi, body / apparatus **;** vesicles moved by microtubules / cytoskeleton (to cell surface membrane) **;** vesicles fuse with <u>cell surface membrane</u> **;** active process ***/*** requires ATP **;** AVP **;** e.g. mucins are, polar / hydrophilic**,** so cannot cross, phospholipid bilayer ***/*** hydrophobic core of membrane **or:** mucin molecules are hydrophilic **;** can exit via protein channels **;** by facilitated diffusion **;**	**3**
2(c)	*any **two** from:* (because mucus is too thick) cilia, have difficulty / AW, moving the mucus (upwards) **;** pathogens, build up / not removed / AW **;** more chance of, infection / disease **;** AVP **;**	**2**

Answer for Question 12 (9700_m23_22_2)

Question	Answer	Marks
2(d)(i)	deletion ;	1
2(d)(ii)	transcribed / template ; **R** transcription strand **I** anti-sense / coding, strand	1
2(d)(iii)	AUC AUU GGU GUU ;	1
2(d)(iv)	*any **three** from:* 1 idea of 3 bases coding for 1 amino acid ; 2 introns removed from, primary transcript RNA / AW ; **A** gene splicing / RNA splicing **A** mRNA does not contain introns **R** if not in correct context (primary transcript to mRNA) 3 introns / non-coding DNA, do not code for amino acids ; 4 (only) exons are joined together (to form mRNA) ; 5 DNA triplet / mRNA codon, for STOP does not code for an amino acid ; 6 methionine at start / first amino acid / amino acid coded for by START codon, removed ; 7 AVP ; e.g. ref. to (upstream) enhancer sequences ref. to (downstream) terminator sequences ref. to (non-coding) regulatory sequences / promoter	3

Answer for Question 13 (9700_m23_22_1)

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>1(a)</td><td>
<table>
<tr><th>cell structure</th><th>eukaryotic cells</th><th>prokaryotic cells</th></tr>
<tr><td>nucleus</td><td>✓</td><td>×</td></tr>
<tr><td>Golgi body</td><td>✓</td><td>×</td></tr>
<tr><td>circular DNA</td><td>✓</td><td>✓</td></tr>
<tr><td>70S ribosome</td><td>✓</td><td>✓</td></tr>
</table>
one mark for each correct column ; ;</td><td>2</td></tr>
<tr><td>1(b)</td><td>diagram showing:

dark line(s) labelled as phosphate heads ;
 A phospholipid heads
clear area(s) between pairs of dark lines labelled as, fatty acid tails / hydrocarbon chains / hydrophobic core / AW ;
 R if pointing to intercellular space
clear area between the two cell surface membranes labelled as, interstitial fluid / tissue fluid / extracellular matrix / intercellular space ;
 A intercellular, area / region</td><td>3</td></tr>
</table>

Answer for Question 13 (9700_m23_22_1)

Question	Answer	Marks
1(c)(i)	*G_1 phase:* *any **one** from:* RNA, synthesised / transcribed / translated ; proteins / enzymes, synthesised ; increasing quantity of organelles ; increase in volume of cytoplasm ; **A** growth (at end of G_1 phase) checkpoint passed for dividing or not ; *S phase:* *any **one** from:* DNA (semi-conservative) replication ; doubles, mass **/** number of strands, of DNA ; ref. to each chromosome now comprises two chromatids ;	**2**
1(c)(ii)	*any* **one** *from:* uncontrolled / increased, cell division **/** mitosis ; resting cells could enter mitosis ; more cells move from the G_1 to the S phase ;	**1**

Answer for Question 14 (9700_s23_21_4)

Question	Answer	Marks
4(a)	sequence of, nucleotides / bases, that is part of DNA ; **A** sequence of DNA nucleotides (that) codes for a polypeptide ; **A** protein / enzyme / amino acid chain	**2**

Question	Answer	Marks
4(b)(i)	*must attempt both DNA polymerase and DNA ligase to gain max* *any **five** from:* *DNA polymerase* **1** addition of, activated / phosphorylated, nucleotides ; **2** *ref. to* complementary, nucleotides / bases / strands ; **3** forms phosphodiester bonds ; **4** (between adjacent nucleotides and) elongating / growing, polynucleotide / strand / AW ; **5** *ref. to* proofreading ability of DNA polymerase ; *DNA ligase* **6** joins / AW, Okazaki fragments ; **7** on lagging strand ; **8** forms phosphodiester bonds, between the fragments / to complete phosphate-sugar backbone ;	**5**
4(b)(ii)	S phase / synthesis phase ; **I** 1 as in S1 phase / S unqualified	**1**

Answer for Question 14 (9700_s23_21_4)

Question	Answer	Marks
4(c)(i)	**A** - centromere and **I** kinetochore site of attachment of, chromatids / chromosome(s) to, spindle fibres / microtubules **or** holds, sister / identical, chromatids together ; **R** daughter chromatids **B** - spindle fibres / microtubules, and orientating chromosomes at the (spindle) equator **or** separating chromatids, at end of metaphase / at start of anaphase **or** movement of, chromatids / chromosomes, to (opposite) poles ; *allow 1 mark max if functions incorrect but **A** and **B** named correctly* *allow 1 mark max if functions are correct but **A** named as kinetochore and **B** poorly misspelt attempt at microtubules*	**2**
4(c)(ii)	two separate, chromatids / single-stranded chromosomes ; chromatids attached to spindle with fibres drawn to, poles / centrioles ; single chromatids drawn U-shaped or V-shaped pointing towards the poles ; centromeres drawn in both chromatids ;	**3**

Answer for Question 15 (9700_s23_22_5)

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>5(a)</td><td>
1 four DNA bases named correctly ; correct spellings
2 purine or pyrimidine column correct for A, C, G, T ;

3 final column correct ;
4 uracil (spelled correctly) <u>and</u> pyrimidine ;

if 0 or 1 mark gained, can increase to max 2:
• if 0 marks, can check for two correct rows
• only mp 1, 2 or 3 correct, check for one correct row
• only mp 4 correct, check for a correct A / C / G / T row

<table>
<tr><th>base</th><th>name of base</th><th>purine or pyrimidine</th><th>RNA or DNA or both</th></tr>
<tr><td>A</td><td>adenine</td><td>purine</td><td>both</td></tr>
<tr><td>C</td><td>cytosine</td><td>pyrimidine</td><td>both</td></tr>
<tr><td>G</td><td>guanine</td><td>purine</td><td>both</td></tr>
<tr><td>T</td><td>thymine</td><td>pyrimidine</td><td>DNA</td></tr>
<tr><td>U</td><td>uracil</td><td>pyrimidine</td><td>RNA</td></tr>
</table>
</td><td>4</td></tr>
<tr><td>5(b)(i)</td><td>purine because it is a, double ring structure / has two rings ;
A purine because similar structure to, adenine / guanine</td><td>1</td></tr>
</table>

Answer for Question 15 (9700_s23_22_5)

Question	Answer	Marks
5(b)(ii)	*mp1 / 2 / 4 idea that carbovir triphosphate is more similar to the (activated) DNA nucleotides that are added to the elongating chain by DNA polymerase* *mp3 justifying why it is better to have a nucleotide analogue (carbovir triphosphate) by explaining the role of DNA nucleotides* *look for ora for abacavir* *any **two** from:* **1** carbovir triphosphate is (similar to / same as), an activated nucleotide / a nucleotide / not a nucleoside ; **A** similar to, A / G, nucleotides **I** *ref. to* purine **2** carbovir triphosphate, has (three) phosphates / is activated / is phosphorylated ; **3** detail of, (DNA) polymerase action / (activated DNA) nucleotides ; e.g. (nucleotides are) added to the, growing / elongating, chain (nucleotides) form H bonds with, complementary base / AW (nucleotides are) substrates for DNA polymerase phosphodiester bonds form between nucleotides *allow mp3 in context of carbovir triphosphate (link to mp1)* **4** *ref. to* triangle / triangular cycloalkane, no longer present / not on DNA nucleotides ; **5** AVP ; e.g. carbovir triphosphate better fit to active site of enzyme / AW	**2**

Answer for Question 15 (9700_s23_22_5)

Question	Answer	Marks
5(b)(iii)	*any **four** from:* *carbovir triphosphate can be inserted into a growing chain…* **1** prevents polymerase from adding DNA nucleotide to growing chain / AW ; **A** *idea of* complete (viral) DNA not made if, chain does not elongate / no more nucleotides added **R** adding base **R** *if in context of stop codon / transcription* **I** *ref. to* complementary base pairing **2** similar <u>shape</u> to, substrate / (activated / phosphorylated) nucleotide ; **A** complementary shape to active site of, DNA polymerase / enzyme **3** acts as an inhibitor ; **4,5** further detail of how, inhibitor / carbovir triphosphate, may act ;; *two from = 2 marks* e.g. may be irreversible fits into / binds to, active site of, enzyme / DNA polymerase competes with (DNA) nucleotide for active site **R** base fewer ES complexes form *in context of enzyme with DNA nucleotide* *idea of* fewer enzyme molecules available to bind to nucleotides may cause change in, shape / tertiary structure / 3D structure, of (DNA) polymerase / enzyme **I** *ref. to* complementary base pairing **6** (DNA polymerase) may not form phosphodiester bonds ; **R** between, bases / complementary bases / complementary nucleotides **7** *ref. to* proofreading mechanism ; e.g. error may cause breakdown of (newly synthesised) DNA may be too similar to be noticed as error and not repaired **8** AVP ; e.g. (viral) DNA containing analogue may not be further replicated DNA polymerase cannot move along DNA template strand AW DNA polymerase may become detached from template strand *idea that* carbovir triphosphate, introduces a mutation / changes DNA formed / changes nucleotide sequence	**4**

Answer for Question 16 (9700_s23_22_4)

Question	Answer	Marks
4(a)(i)	label line to any part of nucleolus ; *must touch an area of nucleolus*	1
4(a)(ii)	*any **two** from:* suggestion for structure as a flagellum ; **R** microvillus **A** cilium / undulipodium presence of microtubules ; presence of 9 + 2 (microtubule) arrangement / pattern, (in cross section) ; AVP ; e.g. *ref. to* location on outer part of cell (so can move) / AW circular cross section suggests tubular structure (hence flagellum) / AW e.g. looks cylindrical	2

Answer for Question 16 (9700_s23_22_4)

Question	Answer	Marks
4(a)(iii)	*any **three** from:* *eukaryote because presence of* (true) nucleus / nuclear envelope / nuclear membranes ; mitochondrion ; *if mp1 **and** 2 not gained, allow* double membrane-bound structures nucleolus ; chromatin ; (**X**) has 9+2 pattern of microtubules ; **A** *ref. to* cytoskeleton / microtubules **X** / AW, covered by cell (surface) membrane ; endoplasmic reticulum ; **I** rough / smooth **I** ER / SER / RER **A** Golgi body *not prokaryote because* absence of cell wall ; **I** does not have peptidoglycan cell wall (size) greater than 5 µm ; **A** larger than (typical) prokaryote / bacterial cell **A** valid calculated size using scale bar *if stated as a prokaryote, read whole response and if all ideas refer correctly to eukaryotic structures, allow max 1*	**3**
4(b)(i)	pathogen ; **I** parasite	**1**
4(b)(ii)	*falciparum / malariae / ovale / vivax* ; **A** *knowlesi correct spelling*	**1**

Answer for Question 16 (9700_s23_22_4)

Question	Answer	Marks
4(c)	*any **three** from:* *similarities* vector, qualified ; e.g. vector is, an insect / a fly both, are vector-borne / are carried by a vector both, need / involve, a vector (vector / carrier / insect) feeds / AW, on (human) blood ; **A** both diseases transmitted through blood *differences* *malaria* (vector) is, a mosquito / *Anopheles* ; **ora** (tsetse fly) not a mosquito **R** mosquito / Anopheles, versus insect (only) female (*mosquitos*), feed on blood / transmit disease / are vectors ; *(information given for sleeping sickness is that male and female tsetse flies feed on blood)*	3

Answer for Question 17 (9700_s23_23_1)

Question	Answer	Marks
1(a)(i)	**B** prophase ; **I** early / mid / late **C** metaphase ; **A** early anaphase	**2**
1(a)(ii)	*any **three** from:* **A** identical chromatids for sister chromatids *assume points are related to anaphase, unless stated as telophase* sister / identical, chromatids (of each chromosome) separate / AW ; **A** *idea of spindle fibres pulling apart sister chromatids* *in context of end of metaphase / start of anaphase* movement of / AW, daughter chromosomes / chromosomes / (sister) chromatids, to (opposite) poles (of cell) ; **R** *if context is a chromosome composed of two chromatids* **R** *if context is movement of sister chromatids to same pole* **I** ends of cell movement (to opposite poles) by spindle fibres, contracting / pulling ; **I** moved by spindle fibres centromeres, qualified ; e.g. centromeres divide at start of anaphase (to separate sister chromatids) centromeres leading (during movement so arms of chromosome lagging) *if telophase stated, mark behaviour of chromosomes in telophase to max 2:* (daughter) chromosomes at poles ; **A** sister chromatids at poles **A** *ref. to* two separate groups of (daughter) chromosomes (chromosomes) become diffuse / become long and thin / decondense / uncoil ; **A** become chromatin *ref. to* re-forming nucleolus ;	**3**

Answer for Question 17 (9700_s23_23_1)

Question	Answer	Marks
1(a)(iii)	*any **three** from:* (active during) DNA replication / S phase / synthesis phase ; **A** during synthesis of DNA / semi-conservative replication joins / AW, Okazaki fragments ; **A** description of Okazaki fragments on lagging strand ; (by catalysing) formation of phosphodiester bonds (between adjacent nucleotides) ; to complete sugar phosphate backbone / AW ; e.g. produces continuous, DNA / polynucleotide, strand	**3**
1(b)(i)	at both ends (of interphase chromosomes) ; **A** on the ends (of, a chromosome	**1**
1(b)(ii)	*any **three** from:* telomeres, maintained / AW, for, longer / greater length of time ; allows increased, number of cell cycles / DNA replication cycles / AW ; **A** allows, mitosis / cell division, to occur more times AW **R** speeds up, mitosis / cell division / cell cycle *idea of* prevents loss of genes (at ends of chromosomes, for a longer time) ; **A** loss of, genetic information / coding DNA **A** less, genes / AW, lost **I** loss of genetic material *ref.* greater ability to replace, damaged / worn out / old, cells ; *in context of active for a longer time* *idea of* cell metabolism remains optimal / cell does not go through apoptosis / AW ;	**2**

Answer for Question 18 (9700_s23_23_4)

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>4(a)(i)</td><td>
<table>
<tr><th>description</th><th>level of protein structure</th></tr>
<tr><td>a gliadin protein is a single polypeptide that forms a compact structure</td><td>tertiary</td></tr>
<tr><td>20% of the amino acids in a glutenin molecule are glycine</td><td>primary</td></tr>
<tr><td>gliadin and glutenin molecules contain regions of β-pleated sheets</td><td>secondary</td></tr>
</table>
1 mark per correct row ;;;
</td><td>3</td></tr>
</table>

Answer for Question 18 (9700_s23_23_4)

Question	Answer	Marks
4(a)(ii)	*any **one** relevant*: e.g. RNA / gene, splicing, not needed / does not occur ; **R** DNA splicing *ref. to* all primary transcript is a coding sequence ; **A** primary transcript has the same sequence as the mRNA no nucleotides removed, from the primary transcript / after transcription ; no process of exon joining / AW ; no non-coding sequences, so introns to not need to be removed ; no alternative RNA splicing / exons not joined in different combinations ; **A** only one type of mRNA formed / mRNA formed always the same *idea that* only other post transcriptional processing occurs ; e.g. 5' G (guanine) cap / poly A tail	**1**
4(b)(i)	endocytosis ; **A** pinocytosis **A** described detail ; e.g. invagination of membrane / AW use of ATP **A** active process / energy needed formation of (endocytotic / pinocytotic) vesicle *if mp1 gained from description, mp2 must be another detail* *accept other named transport mechanism, with detail*	**2**

Answer for Question 18 (9700_s23_23_4)

Question	Answer	Marks
4(b)(ii)	*any* ***four*** *from*: **1** *ref.* presence of, non-self / foreign, antigen **or** gliadin acts as antigen **or** *ref.* to antigen presentation (by macrophages) ; **2** recognition / activation / AW, of (specific) B- / T-lymphocytes ; **A** clonal selection **3** clonal expansion of B-lymphocytes (and T-lymphocytes) ; AW e.g. form a clone of cells (by mitosis) / divide many times by mitosis **4** T-helper cells, secrete / release, cytokine ; **5** cytokine stimulates, humoral / B-lymphocyte, response ; *if mp4 and mp5 not gained allow one mark for T-helper cells stimulate B-lymphocyte response* **6** B-lymphocytes (differentiate to) form plasma cells ; **7** plasma cells, produce / secrete, (anti-gliadin) antibodies ;	**4**

Answer for Question 19 (9700_w23_21_6)

Question	Answer	Marks
6(a)(i)	S phase / synthesis phase / interphase ;	1
6(a)(ii)	*any **two** from:* does not have an OH group (on C3) so condensation reaction cannot occur ; phosphodiester bond cannot form between deoxyribose and phosphate of adjacent nucleotide ; is a different shape because it has H instead OH (on C3) ; shape not complementary to the active site of DNA polymerase **or** no, enzyme substrate complexes / ESCs, can form ;	2
6(b)(i)	*any **two** from:* (both increase K_m, therefore both) reduce the affinity (of RNA polymerase for its substrate) ; (presence of) F52 reduces the affinity for the substrate more than F47 ; ora for F47 AVP ; e.g. manipulation of data to support described trend correct link stated between K_m values and affinity	2

Answer for Question 19 (9700_w23_21_6)

Question	Answer	Marks
6(b)(ii)	*any **three** from:* *decreased, maximum rate of reactions / rate of transcription because* V_{max} lower, qualified ; binding (of the aptamer) changes, the tertiary structure / shape of, active site (of RNA polymerase) ; **A** binding changes shape of enzyme so active site less complementary to substrate (so) substrate / (RNA) nucleotides, bind less easily to active site ; **A** fewer enzyme-substrate complexes form binding of aptamer prevents, substrate / (RNA) nucleotide, binding to active site ; binding prevents RNA polymerase from binding to template strand ; binding prevents RNA polymerase from forming bond between RNA nucleotides ; AVP ;	**3**

Answer for Question 20 (9700_w23_21_2)

Question	Answer	Marks
2(a)	**X** (nucleolus) synthesis / AW of, ribosomal subunits / ribosomes **;** **A** synthesis of organelles that are the sites of protein synthesis **Y** (chromatin) contains gene(s), coding for the polypeptide(s) / AW **;** **A** site, of transcription / for production of mRNA	**2**
2(b)(i)	primary **;**	**1**
2(b)(ii)	*any **one** from:* carboxylic acid / carboxyl, group **;** **A** both have C=O contain carbon / hydrogen / oxygen **;**	**1**

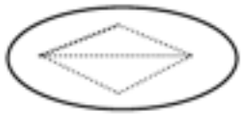
Answer for Question 20 (9700_w23_21_2)

Question	Answer	Marks
2(b)(iii)	*any **three** from:* *ref. to* role in / forms part of, overall 3D shape **;** **A** tertiary / quaternary structure **A** forms part of hydrophobic region of ghrelin allows ghrelin to bind to receptor **;** allows, ghrelin / part of ghrelin, to have a complementary shape / be complementary (to the receptor) **;** **A** description suggested detail **;** e.g. interacts with hydrophobic region of the receptor molecule (for binding) AVP **;** e.g. help interaction with / embeds in, hydrophobic portion of the cell surface membrane *in context of bringing a complementary part of the molecule closer to receptor for binding* suggestion that fatty acid chain allowed, incorporation into / attachment to, a transport molecule in plasma to reach target cell *ref. to* effect of binding triggering reactions inside the cell **;**	**3**
2(c)(i)	1.8% **;** working **;** $\frac{30 \times 3}{5000} \times 100$ *codons for 29 amino acids (including start met) and a stop codon* *allow 1 mark if only 28 or 29 instead of 30, so 1.7% answer obtained*	**2**

Answer for Question 20 (9700_w23_21_2)

Question	Answer	Marks
2(c)(ii)	*any **two** from:* introns / non-coding regions, removed / AW ; exons / coding regions, are joined together ; gene splicing / RNA splicing ; **R** DNA splicing AVP ; e.g. guanine (cap) added (to 5′ end) poly A tail / many As, added (to 3′ end)	**2**

Answer for Question 21 (9700_w23_22_1)

Question	Answer	Marks
1(a)	histones ; **A** basic / histone, proteins	**1**
1(b)	*max 2 if the spindle / centrioles extend outside the cell* 1 two chromosomes, each with two chromatids, drawn approximately along central equator area ; **R** if drawn as a, bivalent / homologous pair (close together or further apart) **A** if equator is drawn across wider diameter 2 plus one other drawn feature ; e.g. spindle  *diamond/oval shape, minimum three spindle fibres as shown* **or** spindle fibre from each pole connecting to centromere area of one chromosome **or** centromere drawn holding sister chromatids together **or** <u>pair</u> of centrioles at each pole **3** any three labels **; I** label to chromosome e.g. (sister / identical) chromatid/s centromere spindle / spindle fibres spindle equator / metaphase plate **A** equator *if spindle / spindle fibre label given* centriole/s **A** centrosome(s) / pole(s) *annotations may contain more than one acceptable label* *label lines to touch structure*	**3**

Answer for Question 21 (9700_w23_22_1)

Question	Answer	Marks
1(c)	*assume sequential interphase to prophase if not named* *any **three** from:* *interphase max 2* (chromosomal) DNA replicates **;** **A** DNA synthesis **I** chromatin **R** if stated as in, G1 / G2 (each new molecule of) DNA, complexes / associates / AW, with, histones / proteins **;** sister / identical, chromatids form, qualified **;** e.g. after (DNA) replication /during / end of, S phase *must be clear they are formed before prophase* *prophase max 2* chromatids / chromosome, condense **;** **R** if also in prophase **A** become(s) shorter and fatter **A** coiling / supercoiling, *in context of,* DNA / chromosomes / chromatids **R** chromosomes condense to form chromatin becomes visible / appears, as two (sister / identical) chromatids **;** **I** composed of two chromatids becomes attached to the spindle fibres **;** (spindle) microtubules attach to centromere / kinetochore formation **;**	**3**

Answer for Question 22 (9700_w23_22_4)

Question	Answer	Marks
4(a)	*allow ideas from a diagram* 1 blood arriving, is deoxygenated / has low(er) partial pressure of oxygen **A** low, concentrations / levels, of oxygen **or** oxygen-poor **or** blood arriving has, high(er) partial pressure / AW, of carbon dioxide **;** **A** carbon dioxide-rich 2 *idea that* newly oxygenated blood is, constantly / continually, removed **;** **A** oxygenated blood passed to pulmonary vein **A** oxygen that diffuses, from alveoli / into blood, is transported away (by blood flow)	**2**

Answer for Question 22 (9700_w23_22_4)

Question	Answer	Marks
4(b)	*any **two** from:* allow alveoli to, expand / stretch, on, inhalation / inspiration / breathing in / AW **;** prevent alveoli from, overstretching / rupturing / bursting (on, inhalation / inspiration / breathing in) **; I** collapse recoil / recoiling, to help, exhalation / expiration / breathing out / force air out **;**	**2**
4(c)	*if stated as facilitated diffusion allow max 1 for mp1 or mp2 or mp5* *any **three** from:* 1 membrane / carrier / transport, protein (move phospholipids across into lamellar body) **;** **R** channel protein / cotransporter (protein) 2 has binding site(s) (specific for surfactant phospholipids) **;** **R** ATP binding site for phospholipids / binds ATP **R** has receptors to bind to phospholipids 3 ATP, used / hydrolysed / needed, for active transport / to provide energy (for transport) **;** **A** ATP binding site for active transport **A** *ref. to* ATPase and, active transport / for energy release **I** has / presence of, ATP energy 4 (surfactant) phospholipids move, against a concentration gradient / from a low(er) to a high(er) concentration **;** 5 able to carry out conformational change / AW **;**	**3**
4(d)(i)	**X**: transcription **;** **Y**: translation **;**	**2**

Answer for Question 22 (9700_w23_22_4)

Question	Answer	Marks
4(d)(ii)	*any **three** from:* *allow ecf if introns and exons consistently the wrong way round* 1 introns, are non-coding / do not code for amino acids / are not involved in polypeptide synthesis ; **R** introns are triplets / codons, that are non-coding **I** exons are coding 2 introns are removed, after transcription / from primary transcript / before mRNA is formed ; **R** introns removed from, mRNA / primary mRNA 3 (only) exons (join to) form mRNA ; **A** mRNA, contains / AW, exons **A** only exons are translated *if mp 2 and 3 not awarded, allow one mark for:* gene splicing / RNA splicing / mRNA does not contain introns **or** splicing *if RNA noted within response – this includes the* **A** *for mp4 (UAA etc because these are RNA codons)* ; **R** DNA splicing 4 some (DNA) triplet(s) / (mRNA) codon(s) are STOP codons ; **A** UAA / UAG / UGA, is a STOP codon **or** STOP, codons / triplets, do not code for an amino acid / terminate translation **A** some, triplets / codons, terminate translation so do not code for amino acids **I** *ref. to* premature STOP codons 5 *ref. to* met / first amino acid / amino acid coded for by START codon, (may be) removed after translation ; 6 AVP ; e.g. *ref. to* (non-coding) regulatory sequences	**3**

Answer for Question 23 (9700_w23_22_3)

Question	Answer	Marks
3(a)	aorta / dorsal aorta **;** *correct spelling needed*	**1**
3(b)(i)	*any **one** from:* *context is using gaps for movement between, hepatocyte / tissue fluid, and, blood / sinusoid* **I** *ref. to* red blood cells **I** shorter diffusion, distance / pathway higher rate of / easier for / AW, exchange / movement / AW, of substances **;** **A** named substances / nutrients substances do not have to cross, a cell layer / into and out of endothelial cells **;** larger molecules / plasma proteins, can pass through **;** Kupffer cells can pass through (into tissue fluid) **;** AW **A** *ref. to* other phagocytic cells **R** Kupffer cells can diffuse through **R** if stated as entering hepatocytes	**1**

Answer for Question 23 (9700_w23_22_3)

Question	Answer	Marks
3(b)(ii)	*max 3 if described as phagocytosis of a pathogen rather than a red blood cell* *allow rbc for red blood cell* *any **four** from:* 1 endocytosis / phagocytosis ; 2 described ; e.g. red blood cell, engulfed / enveloped pseudopodia surround red blood cell *max three from* 3 forms (phagocytic) vacuole / (phagocytic) vesicle / phagosome ; 4 lysosome fuses (with phagosome) ; AW merges / joins to / combines with **I** attaches / binds to 5 (lysosome contains) hydrolytic / digestive, enzymes ; **A** hydrolases / named examples 6 digestion to produce haem and globin ; **A** amino acids for globin 7 AVP ; e.g. suggestion of, detection / recognition, of red blood cell	**4**

Answer for Question 23 (9700_w23_22_3)

Question	Answer	Marks
3(c)(i)	*any **three** from:* **I** Golgi body / lysosome / vesicle *mp1 <u>and</u> mp2 complete term needed either in the text or labelled* 1 <u>smooth endoplasmic reticulum</u> labelled on Fig. 3.2 and detail **;** e.g. for, lipid / triglyceride / cholesterol, synthesis tubular appearance / no ribosomes 2 <u>rough endoplasmic reticulum</u> labelled on Fig. 3.2 and detail **;** e.g. for protein, synthesis / AW **A** for enzyme synthesis flattened (sac) appearance ribosomes **A** ribosome(s) labelled <u>and</u> for (plasma) protein synthesis 3 mitochondrion labelled on Fig. 3.2 <u>and</u> detail **;** e.g. many mitochondria for (aerobic) respiration produce ATP / provide energy, (for hepatocyte reactions) **R** generate / make, energy double membrane / presence of cristae *allow if one mitochondrion is correctly labelled and one of the 'circular' mitochondria has a different label e.g lysosome* 4 presence of glycogen granule(s) as, energy / glucose, store **;** **A** releases / provides, glucose 5 presence of lipid droplet(s), as energy store **;** **A** provides fatty acids **A** provides components for cholesterol synthesis *penalise once (from mp1, 2, or 3) if diagram not labelled but structures named correctly and correct detail given*	

Answer for Question 23 (9700_w23_22_3)

Question	Answer	Marks
3(c)(ii)	*any **one** from:* **I** *ref. to* staining or size mitochondrion, bound by / has, double membrane / two membranes **;** **I** peroxisome has (only) one membrane peroxisome no cristae / mitochondrion has cristae **;** **R** cisternae peroxisome spherical shape and mitochondria, different shapes / AW **;** **I** if only peroxisome shape stated **A** circular *for spherical* **A** description e.g. 'sausage' shape	**1**
3(c)(iii)	*any **two** from:* *mitochondrion (ora for peroxisomes)* has, DNA / genes (coding for enzymes) **;** **R** linear DNA **A** genetic, material / information, qualified with, transcription / *ref. to* mRNA / coding for enzymes (70S) ribosomes (site of enzyme synthesis) **;** **R** 80S ribosomes has the enzymes for, transcription / translation, (to synthesise enzymes) **;** can produce ATP (for enzyme synthesis) **;** **R** produce energy **I** has ATP AVP **;** **;** *other suggestions* e.g. has (chaperone) proteins involved in, folding / formation of tertiary structure ATP cannot enter peroxisome to provide energy source peroxisome has enzymes that cause degradation of, one / or more, substance(s) involved in protein synthesis	**2**

Answer for Question 23 (9700_w23_22_3)

Question	Answer	Marks
3(c)(iv)	*any **two** from:* (peroxisome) membrane bound, so rest of cell protected (from hydrogen peroxide) ; **A** hydrogen peroxide can have toxic effects on (rest of) cell / AW (peroxisome) acts as a compartment / specific area / contained, for, more efficient breakdown of hydrogen peroxide / control of reactions ; high concentration of enzyme in one location ; **A** more enzyme-substrate complexes can form provides, optimum / AW, conditions, for (other peroxisome) reactions ; production of oxygen as by-product, so useful for, peroxisome reactions requiring oxygen / mitochondrial function / aerobic respiration ; AVP ; e.g. isolates (peroxisomes) enzymes from rest of cell	**2**

Answer for Question 24 (9700_w23_23_4)

Question	Answer	Marks
4(a)(i)	RNA polymerase ;	1
4(a)(ii)	phosphodiester ;	1
4(b)(i)	5 ;	1
4(b)(ii)	*any **two** from:* 1 other strand is not the template strand / only the template strand is transcribed ; 2 (*if transcribed*) sequence of, nucleotides / bases, in (m)RNA codes for a different sequence of amino acids ; **A** sequence of codons **A** primary transcript for RNA 3 (*if transcribed*) results in a non-functional polypeptide / AW ; **A** codes for a polypeptide with different function 4 translation would be a waste of energy / translation will not occur (as no signalling sequence) ; 5 any suggestion of a possible consequence to structure of collagen ; 6 (m)RNA is single stranded ; 7 AVP ; e.g. RNA polymerase synthesises RNA in the 5' to 3' direction	2
4(c)(i)	*ref. to* (mitochondrial) envelope / two membranes / double membrane / inner membrane and outer membrane ; **R** cell or cell surface membrane inner membrane is folded / crista(e) ; (70S) ribosomes ; **R** 80S ribosomes (mitochondrial) matrix ; **I** DNA	2
4(c)(ii)	0.6 (μm) ; **R** 0.60 (only one significant figure required)	1

Answer for Question 24 (9700_w23_23_4)

Question	Answer	Marks
4(d)	*any **three** from:* 1 active transport, uses ATP / moves (ions) against concentration gradient ; 2 facilitated diffusion, passive / no ATP / no energy / with the gradient / down concentration gradient ; 3 protein, carrier / pump, changes shape / *ref. to* conformation change / has binding site(s) ; 4 channel protein / pore protein, for facilitated diffusion (only) ; **I** carrier protein 5 AVP ; e.g. *ref. to* ionophore(s) / hydrophilic pore in channel proteins / specificity of carrier *or* channel protein(s) *if mp1 and mp2 are not awarded allow one mark for naming active transport and facilitated diffusion*	**3**

Answer for Question 25 (9700_m22_22_6)

Question	Answer	Marks
6(a)	**1** adenine, thymine, cytosine, guanine ; **2** DNA polymerase ; **3** nucleotides ; **4** complementary base pairing ; **5** (DNA) ligase ; **6** semi-conservative (replication) ;	**6**

Question	Answer	Marks
6(b)(i)	**J** metaphase ; **K** prophase ; **L** telophase ; **A** anaphase	**3**
6(b)(ii)	large size / same size as cells in mitosis / ora ;	**1**
6(b)(iii)	1 chromosomes, orientated / arranged / AW, at, (spindle) equator / metaphase plate ; *plus any **one** from:* 2 chromosomes attached to, spindle / spindle fibres, at centromere / kinetochore ; 3 spindle fully formed ; 4 nucleolus has disappeared ; 5 nuclear envelope, has disassembled / broken down / AW ;	**2**

Answer for Question 26 (9700_m22_22_2)

Question	Answer	Marks
2(a)(i)	bone marrow ;	1
2(a)(ii)	*accept points from a diagram* *max **three** from:* 1 detection / recognition ; e.g. detects (named type of) pathogen recognises, (foreign) antigens / antibodies complexed to antigens has receptors (for antigens) 2 engulfs / envelops, pathogen / bacterium / AW ; **A** phagocytosis occurs **A** endocytosis occurs **A** pseudopodia form 3 forms, vacuole / vesicle / phagosome ; 4 ref. to lysosome fusion ; 5 ref. to hydrolytic / digestive, enzymes ; **A** named examples **A** hydrolases 6 ref. to antigen presentation ; 7 AVP ; e.g. (response is) non-specific / innate	3
2(a)(iii)	*any **one** valid suggestion from:* produces inhibitors for / deactivates, lysosomal enzymes ; escapes out of phagosome ; forms resistant spore / is resistant to digestive enzymes ; AVP ; e.g. suggestion of macrophage malfunction	1

Answer for Question 26 (9700_m22_22_2)

Question	Answer	Marks
2(b)	*any **three** from:* 1 production of mucus by, mucous glands / goblet cells ; 2 sticky / AW, mucus **or** mucus traps, pathogens / bacteria / microorganisms ; 3 mucus acts as a barrier (to prevent entry) ; 4 mucus increases distance to reach cells ; 5 cilia on ciliated epithelial cells ; **A** ciliated epithelium 6 cilia, waft / move, mucus / AW ; 7 *idea that* (contaminated) mucus is moved, away from alveoli / away from lung tissue / towards back of mouth / AW ;	**3**
2(c)	*any **one** suggestion from:* blood / plasma / circulatory system ; lymph / lymph system ; within, neutrophils / macrophages / phagocytes ; **A** white blood cells / leucocytes	**1**
2(d)	*any **one** from:* from infected, cows / cattle ; eating contaminated, meat / beef (from infected cattle) ; drinking, raw / unpasteurised, milk (from infected cows) ;	**1**
2(e)	*any **two** from:* increases chances of, killing / AW, all bacteria ; **I** will kill all bacteria (unqualified) **A** will kill all bacteria if bacteria are, susceptible / not resistant if bacteria are resistant to one antibiotic, then still susceptible to other antibiotics / AW ; reduces chance of mutations arising / (if bacteria susceptible) mutations unlikely to occur against all antibiotics ; AVP ; e.g. antibiotic can be stopped because of side effects idea that more effective because different antibiotics will work on different targets (in the bacteria)	**2**

Answer for Question 26 (9700_m22_22_2)

Question	Answer	Marks
2(f)	*any **two** from:* overall trend for both is increase ; rate of increase in cases of MDR-TB greater than rate of increase in cases of TB / AW / ora ; ref. to fluctuations / detail of fluctuations / periods of decrease ;	**2**
2(g)	*any **three** from:* *overall increase in TB cases:* 1 ref. to problems with people living in, poorly ventilated accommodation / close proximity to each other / AW ; 2 vaccination programmes not able to prevent increase / herd immunity insufficient / AW ; *decrease / numbers fairly constant:* 3 ref. to (some) success of, prevention / treatment programme ; **A** described examples *increase in MDR-TB:* 4 people fail to finish course of treatment for normal TB / AW ; 5 ref. to ease of transmission of TB means easy to transmit *MDR-TB ;* *decrease in 2014 for MDR-TB:* 6 suggestion for decrease ; e.g. better, surveillance / cooperation, in completion of drug therapy more successful antibiotics used people better educated about preventing spread *for either increase in TB cases or increase in MDR-TB:* 7 qualified ref. to link between, HIV / HIV/AIDS, and TB ; 8 less money available for, longer drug treatment / vaccination, by, health authorities / governments ; 9 AVP ; e.g. balance between new cases and successfully treated cases means problem still exists in prevention ref. to changes in population size ref. to improvements in data collection ref. to immigration	**3**

Answer for Question 27 (9700_s22_21_6)

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>6(a)</td><td>one mark each correct row

<table>
<tr><th>feature</th><th>mRNA</th><th>DNA</th></tr>
<tr><td>names of four bases</td><td>adenine, cytosine, guanine, uracil</td><td>adenine, cytosine, guanine, thymine ;</td></tr>
<tr><td>name of pentose sugar present</td><td>ribose</td><td>deoxyribose ;</td></tr>
<tr><td>number of strands</td><td>1 ;
I single</td><td>2 ;
I double</td></tr>
</table>
</td><td>3</td></tr>
<tr><td>6(b)(i)</td><td>transcription ;</td><td>1</td></tr>
<tr><td>6(b)(ii)</td><td>can award either mp1 with mp2 ,or mp3 with mp4

1 removal of introns (from primary transcript / RNA) ;
2 exons joined together ;

or

3 splicing ;
4 of, primary transcript / RNA ;</td><td>2</td></tr>
</table>

Answer for Question 27 (9700_s22_21_6)

Question	Answer	Marks
6(c)(i)	*any* ***four*** *from:* **1** *ref. to* amino acid activation / charging amino acids before attachment to tRNA / AW ; **A** aminoacylation **2** tRNA attached to, specific amino acid / glycine ; **R** 'picks up' **3** *idea that* anticodon / CCG, identifies specific amino acid ; **4** tRNA transports / AW, amino acid to ribosome ; **5** *ref. to* (tRNA) entering the A (aminoacyl) site in ribosome ; **6** tRNA, anticodon / CCG, binds to mRNA, codon / GGC ; **A** correct ref. to, complementary pairing / base pairing / H bond formation *as AW for binding* **7** (specific) amino acid / glycine, in correct position in the polypeptide chain / AW ; **A** helps to form / AW, primary structure of cotransporter protein **8** AVP ; e.g. tRNA, recycled / reused forms aminoacyl tRNA / amino acid-tRNA complex tRNA-ligase / aminoacyl-tRNA synthetase	**4**
6(c)(ii)	*any* ***three*** *from:* **1** movement of sucrose with, protons / H^+ ions, into companion cells ; **A** correct *ref. to* (other named) assimilates **2** (sucrose moved) from, apoplast / cell wall / mesophyll cell ; **3** sucrose moves against its concentration gradient (into companion cell) ; **4** (needs cotransporter protein because) sucrose is polar so cannot pass through membrane ; **5** maintain concentration gradient for sucrose between companion cell and sieve tube (element) ;	**3**

Answer for Question 28 (9700_s22_22_4)

Question	Answer	Marks
4(a)	**R** if choice given and one is incorrect carbonic acid **;** hydrogencarbonate (ions) **;** **A** bicarbonate (ions)	**2**
4(b)	*any **one** from:* similar / same, active site **;** have the same catalytic amino acids ; similar / same, tertiary structure **;** **A** same quaternary structure	**1**

Answer for Question 28 (9700_s22_22_4)

Question	Answer	Marks
4(c)	*allow pre-RNA for primary transcript* *either exon **or** intron statement required for mp2 to 7, one mark each row* *any **three** from:*	3

exons	introns
1 both, are (nucleotide sequences that are) transcribed / form part of the primary transcript ;	
2 (DNA/RNA) <u>coding</u> (sequences) **R** coding genes **I** exons have the genetic code	(DNA/RNA) <u>non-coding</u> (sequences) **R** non-coding genes
3 (RNA exons) needed / involved / AW, in translation **or** for formation of, polypeptides / proteins / carbonic anhydrase	not involved in translation / AW
if mps 2 and 3 not gained 'exons code for proteins' or ora 1 mark	
4 not removed, from primary transcript / from RNA / during gene splicing / during RNA splicing	removed, from primary transcript / from RNA /during gene splicing / during RNA splicing
5 (join to) form mRNA / contain mRNA codons **A** remain in mRNA	not part of mRNA / in primary transcript only
6 not involved in regulating activity of genes / AW	may have regulatory roles **A** other suggestions for role
7 AVP e.g. (as part of mRNA) leave the nucleus / go to cytoplasm / go to ribosomes	AVP e.g. remain in nucleus

if <u>all</u> are differences and <u>all</u> statements are reversed (i.e. introns for exons and vice versa) max 2 marks

Answer for Question 28 (9700_s22_22_4)

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>4(d)</td><td>allow Hb or hb or Hgb for haemoglobin
two marks for points in left column or two marks for points in right column
<table>
<tr><td>cytoplasm / cytosol ;</td><td>(bound to) cell surface membrane ;</td></tr>
<tr><td>close to haemoglobin (for H^+ uptake)
R in / on / with, hb
or
idea of being dispersed within cell because haemoglobin is distributed throughout ;</td><td>close to, anion exchanger / transport protein, for (easy) exit of hydrogen carbonate (ions) ;</td></tr>
<tr><td>quick for hydrogen carbonate (ions) to be transported out of cell / AW or
H^+ (from dissociation) binds rapidly to haemoglobin or
cytoplasm provides water for reaction to form carbonic acid ;</td><td>able to, hydrate / react with, carbon dioxide as it enters cell ;</td></tr>
</table>
if stated cytoplasm <u>and</u> cell surface membrane, one mark
reason can be taken from either column if correctly linked, one mark</td><td>2</td></tr>
<tr><td>4(e)</td><td>exocytosis ;</td><td>1</td></tr>
<tr><td>4(f)</td><td>any three from:
1 acetazolamide / inhibitor, binds / attaches / AW, to, allosteric site / site other than active site ; R alternative active site

2 (which) changes, shape / tertiary structure / 3-D structure, of active site ;
A active site distorted I protein structure

allow ecf for mp3 and 4 if competitive described (to max 2)
3 substrate(s) / CO_2 / HCO_3^-, cannot, enter / bind to / fit in / AW, active site ;
A active site no longer complementary to, substrate / AW
A enzyme substrate / ES, complexes cannot form
A ESCs cannot form
I ‘substrate / CO_2 / HCO_3^- / ‘cannot bind to enzyme’ without a link to active site
4 product, not formed / released ; A named product

5 ref. to acetazolamide / inhibitor, leaves, allosteric site / enzyme ;
I reversibly binds</td><td>3</td></tr>
</table>

Answer for Question 29 (9700_s22_23_4)

Question	Answer	Marks
4(a)	image length ; **A** magnification triangle magnification 250 (nm) ; (8 mm) **A** 220 (for 7 mm) **A** 230 (for 7.5 mm) **A** 270 (for 8.5 mm) **A** 280 (for 9 mm)	**2**
4(b)	pathogen ;	**1**

Answer for Question 29 (9700_s22_23_4)

Question	Answer	Marks
4(c)	ingests / drinks / AW, contaminated water / water containing the pathogen / food washed in contaminated water / contaminated food ; **A** examples of accidental ingestion e.g. swimming in contaminated rivers **A** faecal / oral, transmission **A** bacteria / *Vibrio* **R** if described as virus	**1**
4(d)	**A** mRNA or messenger RNA *any **three** from:* (one strand only needed) to form mRNA / mRNA is single-stranded ; (m)RNA is, used / needed, to produce, subunit (s) / polypeptide(s) ; (only) one strand (of DNA) is the, template / transcribed, strand ; *idea that* (complementary) copying / transcribing, other DNA strand would not result in, desired / AW, mRNA / polypeptide ;	**3**
4(e)(i)	*any **two** from:* **I** receptor **I** active site (mAbs) specific / different, antigen binding sites / binding sites for antigen ; **A** (each) mAb binds to a, specific / particular, antigen **R** if antibody described as an enzyme (each mAb has) specific / different, tertiary structure / variable region(s) / primary structure / sequence of amino acids ; binding site and antigen have complementary shapes **or** ZAC-3 complementary shape to core polysaccharide and lipid A **or** 2D6 complementary shape to O-polysaccharide ;	**2**

Answer for Question 29 (9700_s22_23_4)

Question	Answer	Marks
4(e)(ii)	*any **four** from:* *yes* *general points* *(agglutination / motility prevented, so)* bacteria less able to, penetrate mucus / attach to intestinal epithelial cells / colonise intestine / AW ; **A** *idea that* fewer bacteria able to, attach / colonise intestine less / no, choleragen / toxin, released ; bacteria passed out in faeces not able to cause disease in others / AW ; *ref. to* phagocytosis more effective ; e.g. macrophages stimulated to carry out phagocytosis *prevention / treatment* (to prevent disease) needs to be given, at early stages / before colonising (intestine) ; <u>passive</u> immunity / <u>passive</u> vaccine ; *must be in context of treatment or immediate protection* *idea that* in addition to immune response (so increased effect) ; e.g. acts beside, immune system / immune system cells acts before the immune response can become effective *ref. to* quicker recovery (if a person has cholera) ; useful when, there is antibiotic resistance / antibiotics cannot be given ; *specific mAb* mAb ZAC-3 may be more effective for cholera caused by, wider range of *V. cholerae* / AW; mAb ZAC-3 may be useful if exact form of *V. cholerae* not known ; mAb 2D6, needs to be targeted against specific *V. cholerae* forms / may not be effective against other *V. cholerae* forms ; **A** not all forms of *V. cholerae* were tested in lab	**4**

Answer for Question 29 (9700_s22_23_4)

Question	Answer	Marks
4(e)(ii)	AVP ; e.g. (only) short-term protection / not active immunity / not long term ref. difficulty in delivering mAbs to intestine e.g. may be, digested / destroyed, as pass through gut need to find a way to get mAbs to the intestine if given intravenously need to pass through to gut lumen may be able to prevent multiplication of bacteria mAbs have been used successfully for other diseases	

Answer for Question 30 (9700_s22_23_5)

Question	Answer	Marks
5(a)	*any **two** from:* *ref. to* can organise / order, enzymes / events, in pathway ; consequence in terms of distance ; e.g. product of one reaction is close to next enzyme (where it acts as substrate) enzyme (more likely to be) closer to substrate distance between enzymes shorter **I** short distance / less distance to travel, unqualified (so) increases chance of successful collisions between substrate and enzymes ; increased rate of formation of final product **or** decrease time for ES complex to occur ; *idea that* products can pass to either side of the membrane ; all reactions, localised / occur in the same location (within the cell) ; AVP ; e.g. membrane provides a source of arachidonic acid **I** phospholipid	**2**
5(b)(i)	(similar shaped) curve to the right of main curve <u>and</u> reaches V_{max} ; **A** increasing to reach V_{max}	**1**

Answer for Question 30 (9700_s22_23_5)

Question	Answer	Marks
5(b)(ii)	stays the same ; increases ;	2
5(c)(i)	the gene / PTGS2, is a sequence of nucleotides, that forms part of a DNA molecule / AW / on chromosome 1 ; **A** bases codes for (the production of) a, polypeptide / enzyme / COX-2 ; **A** protein **I** codes for an amino acid *max one if no example used*	2
5(c)(ii)	*any **two** from:* more, product / compounds, produced that stimulate mitosis ; increased, DNA replication / cell division / mitosis ; **I** *ref. to* cancer cells replicating *idea that,* may lead to / increases chance of / AW, (other) mutations ; mutations can result in oncogenes ; AVP ; e.g. *idea that* proof checking capacity impaired / increased chance of errors	2

Answer for Question 30 (9700_s22_23_5)

Question	Answer	Marks
5(d)	*any **three** from:* phospholipids may be, used in / added to, the (cell surface) membrane ; arachidonic acid, is unsaturated / polyunsaturated ; has, C=C / (carbon-carbon) double bonds ; *allow ecf if stated as saturated* unsaturated fatty acid tails, have kinks / not linear / AW ; **A** double bonds produce, kinks / AW increased distance between, phospholipids / other fatty acid tails ; **A** phospholipids cannot pack closely together less hydrophobic interactions between phospholipid (molecules) ;	**3**

Answer for Question 31 (9700_w22_21_3)

Question	Answer	Marks
3(a)(i)	*any **two** from:* spherical / ball shaped ; (water-) soluble ; amino acids with hydrophilic R groups / hydrophilic amino acids, on outside of molecule ; **A** amino acids with hydrophobic R groups in centre of molecule physiological / metabolic, role ; carbonic anhydrase is an enzyme, (enzymes are globular proteins) ;	**2**
3(a)(ii)	*any **two** from:* catalyses / AW, reaction between water and carbon dioxide ; (to form) carbonic acid ; catalyses formation of carbon dioxide and water from carbonic acid in lungs ;	**2**
3(b)(i)	guanine ; *any **two** from:* double ring (base) / purine (base) ; forms three hydrogen bonds with complementary base ; AVP ; e.g. detail of difference between adenine and guanine	**3**

Answer for Question 31 (9700_w22_21_3)

Question	Answer	Marks
3(b)(ii)	*any **four** from:* three bases / triplet of bases / codon, code(s) for one amino acid ; frameshift mutation ; change in, triplet of bases / codon ; *ref. to* every, triplet / codon, after deletion will be different ; may introduce a stop codon ; primary structure / sequence of amino acids / AW, will be altered ; (stop codon results in) formation of, shortened / truncated, polypeptide ; AVP ; e.g. *ref. to* errors in RNA splicing *ref. to* affects post-translational modification bonds that form between R groups, will / may, be altered tertiary structure of protein will be altered non-functional protein formed altered function of the protein	**4**
3(b)(iii)	*any **one** valid suggestion e.g.:* no effect on protein structure (because introns are non-coding) ; non-functional / reduced function of, protein (as intron not spliced after transcription) ; may affect regulation of gene expression ; **A** example e.g. reduction in the rate of transcription RNA polymerase does not bind *ref. to* errors in RNA splicing ; *ref. to* formation of an oncogene ;	**1**

Answer for Question 32 (9700_w22_22_2)

Question	Answer	Marks
2(a)	**S** = protein ; **A** amino acid **R** protein coat **I** capsomere **T** = capsid ; **A** protein coat **R** capsomere	**2**

Question	Answer	Marks
2(b)	170 (nm) ;	**1**
2(c)	replication / synthesis / AW, of (viral) DNA ; **I** replication of genes **A** *stated function of DNA polymerase* **I** unwinding of DNA e.g. forms phosphodiester bonds joins / AW, (adjacent DNA) nucleotides **R** joins complementary nucleotides **I** joins sugar phosphate backbone	**1**
2(d)	presence of (viral), envelope / (outer) membrane / phospholipid bilayer ; ref. fluid / flexible ; ref. to preparation (for electron microscopy) ; e.g. distortion / squashed / artefact **I** ref. to use of the microscope e.g. electron beam affects AVP ; e.g. *suggestion of* variation in <u>tegument</u> protein, number / arrangement / organisation / AW	**2**

Answer for Question 32 (9700_w22_22_2)

Question	Answer	Marks
2(e)	*similarity, one mark:* both have DNA (double stranded, naked / no histones) **;** **A** DNA plus neutral feature e.g. not surrounded by a nuclear envelope **I** both have genes **I** components of DNA e.g. deoxyribose / nucleotides / phosphates **R** both have, single stranded / circular, DNA **R** both have, DNA free in the cytoplasm / DNA and RNA *difference, one mark:* bacterial DNA, circular / closed loop (v HCMV linear) **I** ref. to naked DNA **R** if comparison for HCMV is incorrect e.g. multilayered **or** bacteria (can also) have, plasmid DNA / plasmids **R** if implied that bacterial DNA is only plasmid DNA **or** bacterial DNA (also) has genes for, metabolism / AW **ora** **or** bacterial DNA free in cytoplasm but HCMV DNA surrounded by, capsid / protein coat / **T ;**	**2**

Answer for Question 32 (9700_w22_22_2)

Question	Answer	Marks
2(f)	**I** transcription and translation stops *any **three** from:* **1** no, S phase / G_2 phase / mitosis / cytokinesis **;** **A** remains in (G_1) interphase **A** synthesis phase *for* S phase **I** named mitotic stages *look for* **CON** e.g. 'no S-phase, so mitosis only has one chromatid' **2** (semi-conservative) DNA, replication / synthesis, does not occur **;** **A** sister / identical, chromatids, do not form **R** if a phase is stated and it is not given as the S-phase **3** failure to pass checkpoints / does not reach checkpoints **;** **A** ref. to no error checking occurs (*in context of checkpoints)* **I** proofreading / error checking, (by DNA polymerase) during DNA replication **4** cell does not, grow / increase in size / increase cytoplasm **;** *(context of preparing for mitosis / cytokinesis)* **A** grows to normal (non-dividing) size **5** *idea that* the cell does not, duplicate / synthesise, organelles / extra materials *(context is for, cytokinesis / new cells)* **;** **A** centrioles do not replicate **A** microtubules not synthesised **R** if stated as occurring in S phase (even if e.g. G_2 given as well)	**3**

Answer for Question 32 (9700_w22_22_2)

Question	Answer	Marks
2(g)	*allow virus or pathogen for HCMV* *look for ora in context of healthy immune system* *any **four** from:* **1** ref. to time delay in immune response (compared to normal) **;** e.g. takes a longer time for, immune system to respond slower (secondary) immune response immune response similar to primary response **2** more time / easier / AW, for HMCV to infect cells / replicate / spread (so cause damage) **;** AW **R** ref. to HCMV as, cells that reproduce / viruses that carry out mitosis *impact following primary response and after viral activation* **3** few(er), immune system cells / named, (in circulation) **; I** fewer white blood cells e.g. fewer, macrophages / neutrophils **A** phagocytes fewer (B- and T-) memory cells **A** no memory cells *(no longer present from primary response)* fewer, (B/T,-) lymphocytes / T-helper cells / T-killer (or cytotoxic) cells *context for lymphocytes could be reduced number circulating at time of viral activation or owing to poor secondary response(compared to normal)* fewer / no, plasma cells **4,5** consequence of fewer immune system cells **;;** *two marks* e.g. less chance of / AW, encounter with / recognition of / activation by, (non-self / foreign) antigen / HMCV / virus / pathogen / infected cell (fewer memory cells) ref. reduced clonal expansion / AW (so fewer lymphocytes / plasma cells)	**4**

Answer for Question 32 (9700_w22_22_2)

Question	Answer	Marks
2(g)	(fewer plasma cells) lower concentration of antibodies **A** no antibodies (as no plasma cells) **A** longer time for antibody, production / concentration to build up (fewer T-helper cells) less cytokine released **A** effect of cytokine *if spelling of cytokine* rejected (fewer T-killer cells) fewer infected cells killed / **A** perforin / granzymes / hydrogen peroxide, not released (fewer phagocytes) less phagocytosis for antigen presentation	

Answer for Question 33 (9700_w22_22_3)

Question	Answer	Marks
3(a)	protoctist ;	1
3(b)(i)	*any **two** from:* **1** drugs have different, targets / mechanisms of action, **or** drugs, act on different, structures / processes / stages of life cycle ; **2** unlikely / less likely, for mutations against all drugs to occur ; **3** unlikely for resistance to occur against all the drugs ; **I** immune / immunity **A** described example **4** if there is resistance to one, the other drug(s) will, kill / AW, all pathogens ; AW **I** ref. to effective **5** (so) prevents, gene / allele, from being passed on ; **6** AVP ; e.g. low numbers left, so less probability of mutations arising *idea that* if all pathogens are killed, no replication / no mutations, for resistance to develop	2

Answer for Question 33 (9700_w22_22_3)

Question	Answer	Marks
3(b)(ii)	*allow, pathogens / parasites, for Plasmodium* **I** increased time when person is infectious *any **two** from:* increased time when person, has *Plasmodium* in, blood / circulation **;** *allow mark if reference to, blood / circulation, not made but reference is made to blood in statements about Anopheles* **A** person acts as a reservoir for *Plasmodium* (so) quantity / concentration / number, of *Plasmodium*, remains high / increases **;** AW **A** ref. to allows *Plasmodium*, to reproduce / replicate **I** ref. to genes passing to offspring increased, time / risk / chance / AW, of, being exposed to, vectors / mosquitoes / *Anopheles* (for blood meal) **;** AW *idea of* more infected, *Anopheles* / mosquitoes available to feed on uninfected people **;**	**2**

Answer for Question 33 (9700_w22_22_3)

Question	Answer	Marks
3(c)(i)	**1** correct use of examples **;** *two of gene, gene mutation, protein, altered protein* *gene = kelch13* *gene mutation = kelch13* mutation **or** F446I **or** (mutation has) adenine / A, not, thymine / T *protein/polypeptide* = PfK13 *altered protein* isoleucine / ile, instead of, phenylalanine / phe **2** (mutation has), changed / altered / AW, sequence / arrangement / order, of nucleotides / bases, (in DNA) **;** *ref. A replacing T still needs stated idea of a changed sequence* **R** *if gene explanation also given and stated as sequence of amino acids* **3** (gene) codes for the production of a, polypeptide / protein AW **or** (gene mutation) produces / results in, altered / changed / non-functioning / reduced function, polypeptide / protein **;** AW **A** produces changed sequence of amino acids **R** *if gene and gene mutation explanations given and one is incorrect*	**3**

Answer for Question 33 (9700_w22_22_3)

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>3(c)(ii)</td><td>
allow correct use of extracted data to help confirm points
allow ideas such as higher survival = greater (partial artemisinin) resistance

Key
20 / lower concentration = 20 nmol dm^3 DHA
700 / higher concentration = 700 nmol dm^3 DHA
survival / survival rate = mean percentage survival rate of trophozoite

any three from conclusions 1 to 5:
<table>
<tr><td>1 zero survival of no mutation</td><td>cultures 1 and 4 / no mutations, no survival / 0% survival rate / all killed, at, higher concentration / 700 ;</td></tr>
<tr><td>2
concentrations compared</td><td>lower concentration / 20, higher survival rate than, higher concentration / 700
ora
higher concentration / 700, lower survival rate than, lower concentration / 20 ;
general statement or can take one culture to compare</td></tr>
<tr><td>3
mutation (C580Y and F446I) v no mutation (control / cultures 1&4)</td><td>(A and B strains with) mutations higher survival rate than no mutation
ora
(A and B strains with) no mutation lower survival rate than mutations ;
general statement for both strains, or A, or B
(if concentrations mentioned, need to refer to both concentrations)</td></tr>
<tr><td>4
compare strain A with strain B</td><td>strain A higher survival rate than strain B
ora
strain B lower survival than strain A ;
general statement or comparing groups e.g. 1 and 4 or 2 and 5 or 3 and 6 (for both or one concentration)</td></tr>
<tr><td>5
C580Y v F4461</td><td>C580Y, higher survival than F446I / highest survival rate
or
F446I lower survival rate than C580Y ;
general statement or compare 2 and 3, or 5 and 6, for both or one concentration</td></tr>
</table>
</td><td>3</td></tr>
</table>

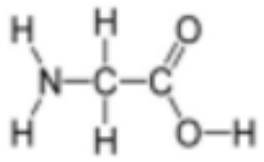
Answer for Question 34 (9700_w22_23_5)

Question	Answer	Marks
5(a)(i)	*any **two** from:* **1** *idea of* the cells have the, same receptor / specific receptor (for LL-37) **;** **2** on cell (surface) membrane / inside cell **;** **3** (shape of) receptor is complementary to (shape of), cathelicidin / signalling compound / ligand **;** **I** antigen **R** active site	**2**
5(a)(ii)	*any **two** from:* **1** thin cells **;** **A** (they are) squamous **R** 'made of squamous epithelial cells' **I** flat / flattened **R** 'they have thin (cell) walls' **2** smooth / AW, (luminal) surface **;** **3** cells are wider in region of the nucleus **;** **A** nucleus bulges from cell **4** ref to, endothelial pores / fenestrations / pores between cells / gaps between cells **;**	**2**
5(b)(i)	(TTC to TAC) change from phe to tyr (at position 5) **;** **I** 'tyr' unqualified	**1**

Answer for Question 34 (9700_w22_23_5)

Question	Answer	Marks
5(b)(ii)	*allow two marks for* new sequence is leu arg val ile ser ser gly asp leu ;; *or allow any **two** from:* **I** refs to frameshift **1** sequence after, first amino acid / first leu, is different ; **R** 'after position 2' **A** 'from position 2 onwards' **2** any example ; e.g. amino acid (at position 2) is arg **3** shortened polypeptide / early chain termination ;	**2**
5(b)(iii)	*any **two** from:* peptide is 3 amino acids in length / shortened polypeptide ; stop codon in position 4 ; (third) amino acid is still, gly(cine) / the same ;	**2**
5(c)	(genetic code) is the, same / similar, in all organisms AW **or** *idea that* each triplet codes for the same amino acid in all living organisms ;	**1**
5(d)	*any **two** from:* **1** (most) amino acids have more than one, triplet / codon ; **2** any correct example(s) from Table 5.2 ; *if award this then award mp1 as well* **3** genetic code is, degenerate / redundant ; **R** degenerative / degenerated **4** *idea that* 64 / 61, possible codons for 20 different amino acids ;	**2**

Answer for Question 35 (9700_m21_22_2)

Question	Answer	Marks
2(a)(i)	sequence of nucleotides **or** length / section / AW, of DNA ; **A** bases for nucleotides (a gene can) code for a polypeptide ; **A** protein for polypeptide	**2**
2(a)(ii)	 amino group added correctly ; **A** H_2N (remaining part of) carboxylic acid group added correctly ; **A** OH for O–H	**2**
2(a)(iii)	amylose <u>and</u> amylopectin ;	**1**

Answer for Question 35 (9700_m21_22_2)

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(b)</td><td>one mark for glucose and starch rows ;
one mark for maltase row ;
one mark for maltose row ;

<table><tr><th>substance</th><th>polysaccharide</th><th>monosaccharide</th><th>macromolecule</th></tr><tr><td>glucose</td><td>✗</td><td>✓</td><td>✗</td></tr><tr><td>maltase</td><td>✗</td><td>✗</td><td>✓</td></tr><tr><td>maltose</td><td>✗</td><td>✗</td><td>✗</td></tr><tr><td>starch</td><td>✓</td><td>✗</td><td>✓</td></tr></table></td><td>3</td></tr>
<tr><td>2(c)</td><td>any one valid suggestion ;
e.g. easier to extract
idea that microorganisms can be cultured in large quantities and produce large amounts of enzyme
higher rate of reaction
active over a greater temperature range</td><td>1</td></tr>
<tr><td>2(d)(i)</td><td>any three from:

1 increase in temperature increases kinetic energy of, molecules / particles / substrate / enzyme ;
A moving around faster

2 (increase in temperature) increases rate of, successful collisions between enzyme and substrate / enzyme–substrate complex formation / substrate binding to active site ;
OR
at 48 °C (47 or 49) ref. to, optimum temperature / maximum enzyme activity / active sites binding substrate at maximum capacity / AW ;

3 (at temperatures higher than optimum) ref. to denaturation / loss of shape of active site (and decrease in activity) ;

4 AVP ; e.g. weaker / hydrogen, bonds break (and ref. to denaturation)</td><td>3</td></tr>
</table>

Answer for Question 36 (9700_s21_21_1)

Question	Answer	Marks
1(a)	actual width = image width ÷ magnification ; **A** A = I ÷ M M = I ÷ A I = A × M or magnification triangle working = width divided by 4275 ; e.g. 16 000 ÷ 4275 17 000 ÷ 4275 18 000 ÷ 4275 19 000 ÷ 4275 ; 3.7 (µm) 4.0 (µm) 4.2 (µm) 4.4 (µm) ; **R** answer if given to more than 1 dp or whole number	**3**
1(b)(i)	DNA – **A** / **B** / **C** ; cellulose – **E** ; phospholipid – **A** / **C** ; histone proteins – **A** / **B** ;	**4**
1(b)(ii)	chloroplast / mitochondrion ;	**1**
1(b)(iii)	nucleus ; **A** chloroplast / mitochondrion **R** nucleolus	**1**

Answer for Question 36 (9700_s21_21_1)

Question	Answer	Marks
1(c)	*any two from* **1** (section at) high <u>resolution</u> ; **A** suggestion of a correct value of resolution for a TEM **2** any named structure visible in Fig. 1.1 that can, only be seen in a TEM / not be seen in a photomicrograph ; e.g. internal structure of chloroplasts / thylakoid(s) / grana e.g. internal structure of mitochondria / cristae **3** high magnification / higher magnification (magnification > 1000 / higher than with light microscope) ; *in context of higher than light microscope* **4** (very) thin ; **5** 2D / no surface contours / no surface features / AW ; **A** not 3D	**2**

Answer for Question 37 (9700_s21_22_1)

Question	Answer	Marks
1(a)(i)	**E** = metaphase ; **F** = anaphase ; **I** early / mid / late **R** more than one stage given for either **E** or **F**	**2**
1(a)(ii)	*any one from* (assemble) to form / become part of / AW, spindle fibres / spindle ; attach to, centromere ; **A** kinetochore *for centromere* **A** form (part of) kinetochore **A** to connect, chromatid / chromosome, to, spindle / spindle fibres **I** to connect, chromosome / centromere, to centrosome example of allowing movement of, chromosomes / chromatids ; e.g. **A** to, pull chromosomes / orientate chromosomes, at equator **A** to pull (sister) chromatids apart (at anaphase) **A** to move, (sister) chromatids / daughter chromosomes, to poles	**1**
1(a)(iii)	**must state 'plant' to gain mark** **I** vacuoles / large permanent vacuole / vague ref. to shape *any one from* cell walls present; uniform / regular, shape of cells ; no, cleavage furrow / pinching in of cytoplasm (in cells at cytokinesis) ; cell plate present (in late telophase / cytokinesis, stages) ;	**1**

Answer for Question 37 (9700_s21_22_1)

Question	Answer	Marks
1(b)	**R** *any answers where a choice is given* **A** hydrogen ; **B** (DNA) ligase ; **C** DNA polymerase ; **R** RNA polymerase **I** roman numerals, e.g. DNA polymerase I **D** telomeres ;	**4**

Answer for Question 38 (9700_s21_22_3)

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>3(a)(i)</td><td>accept from either column for mark and assume blood if not stated
any three from
<table>
<tr><th>blood</th><th>tissue fluid</th><th></th></tr>
<tr><td>has red blood cells</td><td>has no red blood cells</td><td>;</td></tr>
<tr><td>more, white blood cells / leucocytes / named e.g. neutrophils, lymphocytes, monocytes
or
fewer macrophages</td><td>fewer white blood cells / leucocytes / named e.g. neutrophils, lymphocytes, monocytes
or
more macrophages</td><td>;</td></tr>
<tr><td>has platelets</td><td>has no platelets</td><td>;</td></tr>
<tr><td>has, more protein / large proteins
or
has, plasma proteins / named example e.g albumin / fibrinogen / globulin
these are large proteins</td><td>has, fewer / no large, proteins
or
has no, plasma proteins / named example e.g. albumin / fibrinogen / globulin
only allow <u>fewer</u> plasma proteins if clear the proteins present are small enough to leave blood</td><td>;</td></tr>
<tr><td>higher, concentration / AW, oxygen
A more oxygenated</td><td>lower, concentration / AW, oxygen
A less oxygenated</td><td>;</td></tr>
<tr><td>higher, concentration / AW, glucose / amino acids / fatty acids</td><td>lower, concentration / AW, glucose / amino acids / fatty acids</td><td>;</td></tr>
<tr><td>lower, concentration / AW, carbon dioxide A urea, in liver / muscles
I waste</td><td>higher, concentration / AW, carbon dioxide A urea, in liver / muscles
I waste</td><td>;</td></tr>
<tr><td>higher pressure</td><td>lower pressure</td><td>;</td></tr>
</table></td><td>3</td></tr>
<tr><td>3(a)(ii)</td><td>lymph ; A lymphatic fluid</td><td>1</td></tr>
</table>

Answer for Question 38 (9700_s21_22_3)

Question	Answer	Marks
3(b)	*any two from:* 1 can cross / AW, hydrophobic core (of bilayer) / phospholipid bilayer **or** can pass through gaps between, fatty acid tails / phospholipids ; 2 is, hydrophobic / lipid-soluble / non-polar / not ionic / not charged **or** not, hydrophilic / water-soluble / polar / ionic / charged ; 3 small size ;	**2**
3(c)	**Reject** if hormone S or receptor **R** described as an antigen or enzyme complementary (shape) to / only fits into / specificity for (binding to), **R** / receptor ;	**1**
3(d)(i)	nuclear pore ; **A** nuclear pores	**1**
3(d)(ii)	**B** = transcription ; **C** = translation ;	**2**
3(d)(iii)	(80S) ribosome ; **I** 70S	**1**

Answer for Question 38 (9700_s21_22_3)

Question	Answer	Marks
3(e)	*any four from* 1 (formation of), secondary / 2° / second level, structure with, alpha-helix / α-helix / beta-pleated sheet(s) / β-pleated sheet(s) ; **A** β-conformation for β-pleated sheet **I** incorrect detail of bonds 2 folding / coiling, to form tertiary / 3° / third level, structure ; **A** *ref. to* 3D structure as alternative to, folding / coiling **A** secondary structure, folds / coils, to form tertiary structure **R** alpha helix / beta-pleated sheet, coils / folds 3 *two of* hydrogen bonds / ionic or electrostatic bonds / disulfide bonds or bridges / hydrophobic interactions ; **I** peptide bonds *as part of a list that contains two correct bond types* *these must be in context of tertiary structure* 4 (formation of), quaternary / 4° / fourth level structure ; **A** description e.g. polypeptides held together by, interactions / hydrogen bonds / ionic bonds / disulfide bonds **R** if peptide bonds included 5 (globular protein) has hydrophilic, amino acids / R-groups / side chains, to, outside / AW ; **ora** hydrophobic, amino acids / R-groups / side chains, towards centre / AW 6 example of other post-translational modification ; e.g. removal, methionine / met addition sugar group / glycosylation addition phosphate group / phosphorylation addition prosthetic group	**4**